PRESIDENCY UNIVERSITY

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PROGRAMME REGULATIONS & CURRICULUM

2023-27

PRESIDENCY SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BACHELOR OF TECHNOLOGY

VLSI

PRESIDENCY UNIVERSITY

Presidency University Act, 2013 of the Karnataka Act No. 41 of 2013 | Established under Section 2(f) of UGC Act, 1956
Approved by AICTE, New Delhi

PRESIDENCY SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Program Regulations and Curriculum

2023-2027

BACHELOR OF TECHNOLOGY (B.Tech.) in

VLSI

based on Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(As amended up to the 24th Meeting of the Academic Council held on 3rd August 2024. This document supersedes all previous guidelines)

Regulations No.: PU/AC-24.10/ECE19/EVL/2023-27

Resolution No.10 of the 24th Meeting of the Academic Council held on 03rd August 2024, and ratified by the Board of Management in its 24th Meeting held on 05th August, 2024.

AUGUST-2024

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PART A – PROGRAM REGULATIONS

1. Vision & Mission of the University and the School / Department

1.1 Vision of the University

To be a Value-driven Global University, excelling beyond peers and creating professionals of integrity and character, having concern and care for society.

1.2 Mission of the University

- Commit to be an innovative and inclusive institution by seeking excellence in teaching, research and knowledge-transfer.
- Pursue Research and Development and its dissemination to the community, at large.
- Create, sustain and apply learning in an interdisciplinary environment with consideration for ethical, ecological and economic aspects of nation building.
- Provide knowledge-based technological support and services to the industry in its growth and development.
- To impart globally-applicable skill-sets to students through flexible course offerings and support industry's requirement and inculcate a spirit of new-venture creation.

1.3 Vision of Presidency School of Engineering

To be a value based, practice-driven School of Engineering and Technology, committed to developing globally-competent Engineers, dedicated to transforming Society.

1.4 Mission of Presidency School of Engineering

- Cultivate a practice-driven environment with a contemporary Learning-pedagogy, integrating theory and practice.
- Attract and nurture world-class faculty to excel in Teaching and Research, in the field of Core Engineering.
- Establish state-of-the-art facilities for effective Teaching and Learning-experiences.
- Promote Interdisciplinary Studies to nurture talent and impart relevant skill-sets for global impact.
- Instil Entrepreneurial and Leadership Skills to address Social, Environmental, and Community-needs.

1.5 Vision of Department of Electronics and Communication Engineering

To be a value-based, industry driven Electronics and Communication Engineering Department committed to develop globally competent Electronics and Communication Engineering professionals dedicated to transform the society.

1.6 Mission of Department of Electronics and Communication Engineering

- Committed to inculcate application of Engineering knowledge, develop problem analysis and solving skills to be able to investigate complex engineering problems with modern tools.
- Create value-driven engineering professionals who are sensitive to societal concerns of environmental sustainability through ethical conduct.

- Develop excellent communication abilities with core skills of project management and team work.
- Imbibe passion for lifelong learning with individual growth path.
- Commitment towards excellence in Electronics and Communication Engineering education through advancements in research and innovation.
- Design flexible course contents in disciplinary, interdisciplinary and research areas to enhance student's competitiveness.

2. Preamble to the Program Regulations and Curriculum

This is the subset of Academic Regulations and it is to be followed as a requirement for the award of B.Tech degree.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Social Project Based Learning, Industrial Training, and Internship to enable the students to become eligible and fully equipped for employment in industries, choose higher studies or entrepreneurship.

In exercise of the powers conferred by and in discharge of duties assigned under the relevant provision(s) of the Act, Statutes and Academic Regulations of the University, the Academic Council hereby makes the following Regulations.

3. Short Title and Applicability

a. These Regulations shall be called the Bachelor of Technology Degree Program Regulations and Curriculum 2023-2027.
b. These Regulations are subject to, and pursuant to the Academic Regulations 2025.
c. These Regulations shall be applicable to the ongoing Bachelor of Technology Degree Programs of the 2023-2027 batch, and to all other Bachelor of Technology Degree Programs which may be introduced in future.
d. These Regulations shall supersede all the earlier Bachelor of Technology Degree Program Regulations and Curriculum, along with all the amendments thereto.
e. These Regulations shall come into force from the Academic Year 2023-2024.

4. Definitions

In these Regulations, unless the context otherwise requires:

a. "Academic Calendar" means the schedule of academic and miscellaneous events as approved by the Vice Chancellor;
b. "Academic Council" means the Academic Council of the University;
c. "Academic Regulations" means the Academic Regulations, of the University;
d. "Academic Term" means a Semester or Summer Term;
e. "Act" means the Presidency University Act, 2013;
f. "AICTE" means All India Council for Technical Education;
g. "Basket" means a group of courses bundled together based on the nature/type of the course;
h. "BOE" means the Board of Examinations of the University;
i. "BOG" means the Board of Governors of the University;
j. "BOM" means the Board of Management of the University;

k. *"BOS" means the Board of Studies of a particular Department/Program of Study of the University;*

l. *"CGPA" means Cumulative Grade Point Average as defined in the Academic Regulations;*

m. *"Clause" means the duly numbered Clause, with Sub-Clauses included, if any, of these Regulations;*

n. *"COE" means the Controller of Examinations of the University;*

o. *"Course In Charge" means the teacher/faculty member responsible for developing and organising the delivery of the Course;*

p. *"Course Instructor" means the teacher/faculty member responsible for teaching and evaluation of a Course;*

q. *"Course" means a specific subject usually identified by its Course-code and Course-title, with specified credits and syllabus/course-description, a set of references, taught by some teacher(s)/course-instructor(s) to a specific class (group of students) during a specific Academic Term;*

r. *"Curriculum Structure" means the Curriculum governing a specific Degree Program offered by the University, and, includes the set of Baskets of Courses along with minimum credit requirements to be earned under each basket for a degree/degree with specialization/minor/honours in addition to the relevant details of the Courses and Course catalogues (which describes the Course content and other important information about the Course). Any specific requirements for a particular program may be brought into the Curriculum structure of the specific program and relevant approvals should be taken from the BOS and Academic Council at that time.*

s. *"DAC" means the Departmental Academic Committee of a concerned Department/Program of Study of the University;*

t. *"DAC" means, the Departmental Academic Committee;*

u. *"Dean" means the Dean / Director of the concerned School;*

v. *"Degree Program" includes all Degree Programs;*

w. *"Department" means the Department offering the degree Program(s) / Course(s) / School offering the concerned Degree Programs / other Administrative Offices;*

x. *"Discipline" means specialization or branch of B.Tech. Degree Program;*

y. *"HOD" means the Head of the concerned Department;*

z. *"L-T-P-C" means Lecture-Tutorial-Practical-Credit – refers to the teaching – learning periods and the credit associated;*

aa. *"MOOC" means Massive Open Online Courses;*

bb. *"MOU" means the Memorandum of Understanding;*

cc. *"NPTEL" means National Program on Technology Enhanced Learning;*

dd. *"Parent Department" means the department that offers the Degree Program that a student undergoes;*

ee. *"Program Head" means the administrative head of a particular Degree Program/s;*

ff. *"Program Regulations" means the Bachelor of Technology Degree Program Regulations and Curriculum, 2023-2027;*

gg. *"Program" means the Bachelor of Technology (B.Tech.) Degree Program;*

hh. *"PSOE" means the Presidency School of Engineering;*

ii. "Registrar" means the Registrar of the University;

jj. "School" means a constituent institution of the University established for monitoring, supervising and guiding, teaching, training and research activities in broadly related fields of studies;

kk. "Section" means the duly numbered Section, with Clauses included in that Section, of these Regulations;

ll. "SGPA" means the Semester Grade Point Average as defined in the Academic Regulations;

mm. "Statutes" means the Statutes of Presidency University;

nn. "Sub-Clause" means the duly numbered Sub-Clause of these Program Regulations;

oo. "Summer Term" means an additional Academic Term conducted during the summer break (typically in June-July) for a duration of about eight (08) calendar weeks, with a minimum of thirty (30) University teaching days;

pp. "SWAYAM" means Study Webs of Active Learning for Young Aspiring Minds.

qq. "UGC" means University Grant Commission;

rr. "University" means Presidency University, Bengaluru; and

ss. "Vice Chancellor" means the Vice Chancellor of the University.

5. Program Description

The Bachelor of Technology Degree Program Regulations and Curriculum 2023-2027 are subject to, and, pursuant to the Academic Regulations. These Program Regulations shall be applicable to the following ongoing Bachelor of Technology (B.Tech.) Degree Programs of 2023-2027 offered by the Presidency School of Engineering (PSOE):

1. Bachelor of Technology in Civil Engineering, abbreviated as B.Tech. (Civil Engineering)

2. Bachelor of Technology in Electronics and Communication Engineering, abbreviated as B.Tech. (Electronics and Communication Engineering)

3. Bachelor of Technology in VLSI, abbreviated as B.Tech. (EVL)

4. Bachelor of Technology in VLSI Design Technoloy, abbreviated as B.Tech. (EVT)

5. Bachelor of Technology in Electrical and Electronics Engineering, abbreviated as B.Tech. (Electrical and Electronics Engineering)

6. Bachelor of Technology in Mechanical Engineering, abbreviated as B.Tech. (Mechanical Engineering); and

7. Bachelor of Technology in Petroleum Engineering, abbreviated as B.Tech. (Petroleum Engineering)

5.1 These Program Regulations shall be applicable to other similar programs, which may be introduced in future.

5.2 These Regulations may evolve and get amended or modified or changed through appropriate approvals from the Academic Council, from time to time, and shall be binding on all concerned.

5.3 The effect of periodic amendments or changes in the Program Regulations, on the students admitted in earlier years, shall be dealt with appropriately and carefully, so as to ensure that those students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised Program Regulations, without any undue favour or considerations

6. Minimum and Maximum Duration

6.1 Bachelor of Technology Degree Program is a Four-Year, Full-Time Semester based program. The minimum duration of the B.Tech. Program is four (04) years and each year comprises of two academic Semesters (Odd and Even Semesters) and hence the duration of the B.Tech. program is eight (08) Semesters.

6.2 A student who for whatever reason is not able to complete the Program within the normal period or the minimum duration (number of years) prescribed for the Program, may be allowed a period of two years beyond the normal period to complete the mandatory minimum credits requirement as prescribed by the concerned Program Regulations and Curriculum. In general, the permissible maximum duration (number of years) for completion of Program is 'N' + 2 years, where 'N' stands for the normal or minimum duration (number of years) for completion of the concerned Program as prescribed by the concerned Program Regulations and Curriculum.

6.3 The time taken by the student to improve Grades/CGPA, and in case of temporary withdrawal/re-joining (Refer to Clause **Error! Reference source not found.** of Academic Regulations), shall be counted in the permissible maximum duration for completion of a Program.

6.4 In exceptional circumstances, such as temporary withdrawal for medical exigencies where there is a prolonged hospitalization and/or treatment, as certified through hospital/medical records, women students requiring extended maternity break (certified by registered medical practitioner), and, outstanding sportspersons representing the University/State/India requiring extended time to participate in National/International sports events, a further extension of one (01) year may be granted on the approval of the Academic Council.

6.5 The enrolment of the student who fails to complete the mandatory requirements for the award of the concerned Degree (refer Section 19.**Error! Reference source not found.** of Academic Regulations) in the prescribed maximum duration (Sub-Clauses 18.1 and 18.2 of Academic Regulations), shall stand terminated and no Degree shall be awarded.

7 Programme Educational Objectives (PEO)

After four years of successful completion of the program, the graduates shall be:

PEO1. Demonstrate as a successful VLSI Professional with innovative skills and with a moral and ethical values.

PEO2. Engage in life-long Learning through Research and Professional Development.

PEO3. Serve as a leader in the profession through consultancy, extension activities or entrepreneurship.

8 Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

8.1 Programme Outcomes (PO)

On successful completion of the Program, the students shall be able to:

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

8.2 Program Specific Outcomes (PSOs):

On successful completion of the Program, the students shall be able to:

PSO1: Identify, formulate and solve VLSI Design-based real-life problems using Artificial Intelligence and Machine Learning techniques.

PSO2: Become a successful engineer by inculcating the concepts of architecture, programming and control for embedded systems design.

PSO3: Evolve as a successful researcher by identifying, evaluating, validating and analysing the engineering problems by using VLSI domain knowledge.

PSO4: Emerge as a successful entrepreneur by understanding the impact of signal processing, communication and develop prototypes for real-world sustainable problems.

9 Admission Criteria (as per the concerned Statutory Body)

The University admissions shall be open to all persons irrespective of caste, class, creed, gender or nation. All admissions shall be made on the basis of merit in the qualifying examinations; provided that forty percent of the admissions in all Programs of the University shall be reserved for the students of Karnataka State and admissions shall be made through a Common Entrance Examination conducted by the State Government or its agency and seats shall be allotted as per the merit and reservation policy of the State Government from time to time**.** The admission criteria to the B.Tech. Program is listed in the following Sub-Clauses:

9.1 An applicant who has successfully completed Pre-University course or Senior Secondary School course (+2) or equivalent such as (11+1), 'A' level in Senior School Leaving Certificate Course from a recognized university of India or outside or from Senior Secondary Board or equivalent, constituted or recognized by the Union or by the State Government of that Country for the purpose of issue of qualifying certificate on successful completion of the course, may apply for and be admitted into the Program.

9.2 Provided further, the applicant must have taken Physics and Mathematics as compulsory subjects in the Pre-University / Higher Secondary / (10+2) / (11+1) examination, along with either Chemistry / Biology / Electronics / Computer Science / Biotechnology subject, and, the applicant must have obtained a minimum of 45% of the total marks (40% in case of candidates belonging to the Reserved Category as classified by the Government of Karnataka) in these subjects taken together.

9.3 The applicant must have appeared for Joint Entrance Examinations (JEE) Main / JEE (Advanced) / Karnataka CET / COMED-K, or any other State-level Engineering Entrance Examinations.

9.4 Reservation for the SC / ST and other backward classes shall be made in accordance with the directives issued by the Government of Karnataka from time to time.

9.5 Admissions are offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission, issued from time to time, by the Government of India.

9.6 Candidates must fulfil the medical standards required for admission as prescribed by the University.

9.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation and any other falsification, the Registrar shall report the matter to the Board of Management (BOM), recommending revoking the admission of the candidate.

9.8 The decision of the BOM regarding the admissions is final and binding.

10 Lateral Entry / Transfer Students requirements

10.1 Lateral Entry

The University admits students directly to the second year (3rd Semester) of the B.Tech. Degree program as per the provisions and/or regulations of the Government of Karnataka pertaining to the "Lateral Entry" scheme announced by the Government from time to time. Further, the general conditions and rules governing the provision of Lateral Entry to the B.Tech. Program of the University are listed in the following Sub-Clauses:

10.1.1 Admission to 2nd year (3rd Semester) of the B.Tech. Degree program shall be open to the candidates who are holders of a 3-year Diploma in Engineering (or equivalent qualification as recognized by the University), who have secured not less than forty-five percentage (45%) marks in the final year examination (5th and 6th Semesters of the Diploma Program) in the appropriate branch of Engineering. Provided that, in case of SC / ST and OBC candidates from Karnataka the minimum marks for eligibility shall be forty percent (40%).

10.1.2 Provided further that, candidates seeking Lateral Entry may be required to complete specified bridge Courses as prescribed by the University. Such bridge Courses, if any, shall not be included in the CGPA computations.

10.1.3 All the existing Regulations and Policies of the University shall be binding on all the students admitted to the Program through the provision of Lateral Entry.

10.1.4 The Course requirements prescribed for the 1st Year of the B.Tech. Program shall be waived for the student(s) admitted through Lateral Entry and the duration of the B.Tech. Program for such students is three (03) years, commencing from the 3rd Semester (commencement of the 2nd Year) of the B.Tech. Program and culminating with the 8th Semester (end of the 4th Year) of the B.Tech. Program.

10.1.5 Provided that, if a Lateral Entry student misses any mandatory program

specific courses that are typically offered in the 1st year (1st or 2nd semesters), then those courses must be cleared by the students as soon as possible, preferably during the Summer Term.

10.1.6 The existing Program Regulations of the concerned Program to which the student is admitted through the provision of Lateral Entry shall be binding on the student with effect from the 3rd Semester of the Program. i.e., the Program Structure and Curriculum from the 3rd to 8th Semesters of the Program concerned shall be binding on the student admitted through Lateral Entry. Further, any revisions / amendments made to the Program Regulations thereafter, shall be binding on all the students of the concerned Program.

10.1.7 All the Courses (and the corresponding number of Credits) prescribed for the 1st Year of the concerned B.Tech. Program shall be waived for the student(s) admitted to the concerned B.Tech Program through Lateral Entry. Further, the *Minimum Credit Requirements* for the award of the B.Tech. Degree in the concerned Program shall be prescribed / calculated as follows:

The ***Minimum Credit Requirements*** for the award of the Bachelor of Technology (B.Tech.) Degree prescribed by the concerned Bachelor of Technology Degree Program Regulations and Curriculum, 2023-2027, minus the number of Credits prescribed / accepted by the Equivalence Committee for the 1st Year (1st and 2nd Semesters) of the B.Tech. Program.

For instance, if the *Minimum Credit Requirements* for the award of the Bachelor of Technology (B.Tech.) Degree as prescribed by the Regulations for B.Tech. (VLSI) is "N" Credits, and, if the total credits prescribed in the 1st Year (total credits of the 1st and 2nd Semesters) of the Program concerned is "M" Credits, then the *Minimum Credit Requirements* for the award of the B.Tech. in VLSIl Engineering for a student who joins the Program through the provision of the Lateral Entry, shall be "N – M" Credits.

10.1.8 Further, no other waiver except the Courses prescribed for the 1st year of the B.Tech. Program of the University shall be permissible for students joining the B.Tech. Program through the provision of Lateral Entry.

10.2 Transfer of student(s) from another recognized University to the 2nd year (3rd Semester) of the B.Tech. Program of the University

A student who has completed the 1st Year (i.e., passed in all the Courses / Subjects prescribed for the 1st Year) of the B.Tech. / B.E. / B.S., Four-Year Degree Program from another recognized University, may be permitted to transfer to the 2nd Year (3rd Semester) of the B.Tech. Program of the University as per the rules and guidelines prescribed in the following Sub-Clauses:

10.2.1 The concerned student fulfils the criteria specified in Sub-Clauses 10.1.1, 10.1.2 and 10.1.3.

10.2.2 The student shall submit the Application for Transfer along with a non-refundable Application Fee (as prescribed by the University from time to time) to the University no later than July 10 of the concerned year for admission to the 2nd Year (3rd Semester) B.Tech. Program commencing on August 1 on the year concerned.

10.2.3 The student shall submit copies of the respective Marks Cards / Grade Sheets / Certificates along with the Application for Transfer.

10.2.4 The transfer may be provided on the condition that the Courses and Credits completed by the concerned student in the 1st Year of the B.Tech. / B.E. / B.S. Four Degree Program from the concerned University, are declared equivalent and acceptable by the Equivalence Committee constituted by the Vice Chancellor for this purpose. Further, the Equivalence Committee may also prescribe the Courses and Credits the concerned students shall have to mandatorily complete, if admitted to the 2nd Year of the B.Tech. Program of the University.

10.2.5 The Branch / Discipline allotted to the student concerned shall be the decision of the University and binding on the student.

11. Change of Branch / Discipline / Specialization

A student admitted to a particular Branch of the B.Tech. Program will normally continue studying in that Branch till the completion of the program. However, the University reserves the right to provide the option for a change of Branch, or not to provide the option for a change of Branch, at the end of 1st Year of the B.Tech. Program to eligible students in accordance with the following rules and guidelines: framed by the University from time to time.

11.1 Normally, only those students, who have passed all the Courses prescribed for the 1st Year of the B.Tech. Program and obtained a CGPA of not less than 6.50 at the end of the 2nd Semester, shall be eligible for consideration for a change of Branch.

11.2 Change of Branch, if provided, shall be made effective from the commencement of the 3rd Semester of the B.Tech. Program. There shall be no provision for change of Branch thereafter under any circumstances whatsoever.

11.3 The student provided with the change of Branch shall fully adhere to and comply with the Program Regulations of the concerned Branch of the B.Tech. Program, the Fee Policy pertaining to that Branch of the B.Tech. Program, and, all other rules pertaining to the changed Branch existing at the time.

11.4 Change of Branch once made shall be final and binding on the student. No student shall be permitted, under any circumstances, to refuse the change of Branch offered.

11.5 The eligible student may be allowed a change in Branch, strictly in order of *inter se* merit, subject to the conditions given below:

11.5.1 The actual number of students in the 3rd Semester in any particular Branch to which the transfer is to be made, should not exceed the intake fixed by the University for the concerned Branch;

11.5.2 The actual number of students in any Branch from which transfer is being sought does not fall below 75% of the total intake fixed by the University for the concerned Branch.

The process of change of Branch shall be completed within the first five days of Registration for the 3rd Semester of the B.Tech. Program.

12 Specific Regulations regarding Assessment and Evaluation (including the Assessment Details of NTCC Courses, Weightages of Continuous Assessment and End Term Examination for various Course Categories)

12.1 The academic performance evaluation of a student in a Course shall be according to the University Letter Grading System based on the class performance distribution in the Course.

12.2 Academic performance evaluation of every registered student in every Course registered by the student is carried out through various components of Assessments spread across the Semester. The nature of components of Continuous Assessments and the weightage given to each component of Continuous Assessments (refer Clause 12.5) shall be clearly defined in the Course Plan for every Course, and approved by the DAC.

12.3 Format of the End-Term examination shall be specified in the Course Plan.

12.4 Grading is the process of rewarding the students for their overall performance in each Course. The University follows the system of Relative Grading with statistical

approach to classify the students based on the relative performance of the students registered in the concerned Course except in the following cases:

- Non-Teaching Credit Courses (NTCC)
- Courses with a class strength less than 30

Absolute grading method may be adopted, where necessary with prior approval of concerned DAC.

Grading shall be done at the end of the Academic Term by considering the aggregate performance of the student in all components of Assessments prescribed for the Course. Letter Grades (Clause **Error! Reference source not found.**) shall be awarded to a student based on her/his overall performance relative to the class performance distribution in the concerned Course. These Letter Grades not only indicate a qualitative assessment of the student's performance but also carry a quantitative (numeric) equivalent called the Grade Point.

12.5 Assessment Components and Weightage

Table 1: Assessment Components and Weightage for different category of Courses

Nature of Course and Structure	Evaluation Component		Weightage	Minimum Performance Criteria	
Lecture-based Course L component in the L-T-P Structure is predominant (more than 1) (Examples: 3-0-0; 3-0-2; 2-1-0; 2-0-2, 2-0-4 etc.)	Continuous Assessments	Assignments, Seminars, Poster Presentations, Quizzes, Mini Projects, Term Papers, Hack-a-thons, Make-a-thons, Code-a-thons, etc. as prescribed in the Course Plan	25%	-	40%
		Mid Term Examination (to be conducted by CoE centrally)	25%		
	End Term Examination		50%	30%	
Lab/Practice-based Course P component in the L-T-P Structure is predominant (Examples: 0-0-4; 1-0-4; 1-0-2; etc.)	Continuous Assessments	Laboratory Work / Practical exercises, conducted in every Laboratory / Practice session / activity, including Laboratory records, practice / project reports, attendance / class participation as applicable, and as prescribed in the Course Plan	50%	-	40%

		Mid Term Examination (to be conducted at Department/ School Level during regular lab slots)	25%	
	End Term Examination		25%	30%
Skill based Courses like Industry Internship, Capstone project, Research Dissertation, Integrative Studio, Interdisciplinary Project, Summer / Short Internship, Social Engagement / Field Projects, Portfolio, and such similar Non-Teaching Credit Courses, where the pedagogy does not lend itself to a typical L-T-P structure	Guidelines for the assessment components for the various types of Courses, with recommended weightages, shall be specified in the concerned Program Regulations and Curriculum / Course Plans, as applicable.			40%

The exact weightages of Evaluation Components shall be clearly specified in the concerned PRC and respective Course Plan.

Normally, for Practice/Skill based Courses, without a defined credit structure (L–T–P) [NTCC], but with assigned Credits (as defined in Clause **Error! Reference source not found.** of the Academic Regulations), the method of evaluation shall be based only on Continuous Assessments. The various components of Continuous Assessments, the distribution of weightage among such components, and the method of evaluation/assessment, shall be as decided and indicated in the Course Plan/PRC. The same shall be approved by the respective DAC.

12.6 Minimum Performance Criteria:

12.6.1 Theory only Course and Lab/Practice Embedded Theory Course

A student shall satisfy the following minimum performance criteria to be eligible to earn the credits towards the concerned Course:

a. A student must obtain a minimum of 30% of the total marks/weightage assigned to the End Term Examinations in the concerned Course.

b. The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of the components of Continuous Assessments, Mid Term Examinations and End Term Examinations in the concerned Course.

12.6.2 Lab/Practice only Course and Project Based Courses

The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of all assessment components in the concerned Course.

12.6.3 A student who fails to meet the minimum performance criteria listed above in a Course shall be declared as "Fail" and given "F" Grade in the concerned Course. For theory Courses, the student shall have to re-appear in the "Make-Up Examinations" as scheduled by the University in any subsequent semester, or, re-appear in the End Term Examinations of the same Course when it is scheduled at the end of the following Semester or Summer Term, if offered. The marks obtained in the Continuous Assessments (other than the End Term Examination) shall be carried forward and be included in computing the final grade, if the student secures the minimum requirements (as per Clause 12.6.1, 12.6.2 of academic regulations) in the "Make-Up Examinations" of the concerned Course. Further, the student has an option to re-register for the Course and clear the same in the summer term/ subsequent semester if he/she wishes to do so, provided the Course is offered.

13 Additional clarifications - Rules and Guidelines for Transfer of Credits from MOOC, etc. – Note: These are covered in Academic Regulations

The University allows students to acquire credits from other Indian or foreign institutions and/or Massive Open Online Course (MOOC) platforms, subject to prior approval. These credits may be transferred and counted toward fulfilling the minimum credit requirements for the award of a degree. The process of transfer of credits is governed by the following rules and guidelines:

13.1 The transfer of credits shall be examined and recommended by the Equivalence Committee (Refer **Error! Reference source not found.** of academic regulations) and approved by the Dean - Academics.

13.2 Students may earn credits from other Indian or foreign Universities/Institutions with which the University has an MOU, and that MOU shall have specific provisions, rules and guidelines for transfer of credits. These transferred credits shall be counted towards the minimum credit requirements for the award of the degree.

13.3 Students may earn credits by registering for Online Courses offered by *Study Web of Active Learning by Young and Aspiring Minds* (SWAYAM) and *National Program on Technology Enhanced Learning* (NPTEL), or other such recognized Bodies/ Universities/Institutions as approved by the concerned BOS and Academic Council from time to time. The concerned School/Parent Department shall publish/include the approved list of Courses and the rules and guidelines governing such transfer of credits of the concerned Program from time to time. The Rules and Guidelines for the transfer of credits specifically from the Online Courses conducted by SWAYAM/ NPTEL/ other approved MOOCs are as stated in the following Sub-Clauses:

13.3.1 A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause 13.3 (as per academic regulations) and transfer equivalent credits to partially or fully complete the mandatory credit requirements of Discipline Elective Courses and/or the mandatory credit requirements of Open Elective Courses as prescribed in the concerned Curriculum Structure. However, it is the sole responsibility of the student to complete the mandatory credit requirements of the Discipline Elective Courses and the Open Elective Courses as prescribed by the Curriculum Structure of the concerned Program.

13.3.2 SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 13.3 (as per academic regulations) shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.

13.3.3 Parent Departments may release a list of SWAYAM/NPTEL/other approved MOOCs for Pre-Registration as per schedule in the Academic Calendar or through University Notification to this effect.

13.3.4 Students may Pre-Register for the SWAYAM/NPTEL/other approved MOOCs in the respective Departments and register for the same Courses as per the schedule announced by respective Online Course Offering body/institute/ university.

13.3.5 A student shall request for transfer of credits only from such approved Courses as mentioned in Sub-Clause 13.3.2 above.

13.3.6 SWAYAM/NPTEL/other approved MOOCs Courses are considered for transfer of credits only if the concerned student has successfully completed the SWAYAM/NPTEL/other approved MOOCs and obtained a certificate of successful/satisfactory completion.

13.3.7 A student who has successfully completed the approved SWAYAM/NPTEL/ other approved MOOCs and wants to avail the provision of transfer of equivalent credits, must submit the original Certificate of Completion, or such similar authorized documents to the HOD concerned, with a written request for the transfer of the equivalent credits. On verification of the Certificates/Documents and approval by the HOD concerned, the Course(s) and equivalent Credits shall forwarded to the COE for processing of results of the concerned Academic Term.

13.3.8 The credit equivalence of the SWAYAM/NPTEL/other approved MOOCs are based on Course durations and/or as recommended by the Course offering body/institute/university. The Credit Equivalence mapped to SWAYAM/ NPTEL approved Courses based on Course durations for transfer of credits is summarised in Table shown below. The Grade will be calculated from the marks received by the Absolute Grading Table **Error! Reference source not found.** in the academic regulations.

Table 2: Durations and Credit Equivalence for Transfer of Credits from SWAYAM-NPTEL/ other approved MOOC Courses		
Sl. No.	**Course Duration**	**Credit Equivalence**
1	4 Weeks	1 Credit
2	8 Weeks	2 Credits
3	12 Weeks	3 Credits

13.3.9 The maximum permissible number of credits that a student may request for credit transfer from MOOCs shall not exceed 20% of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree.

13.3.10 The University shall not reimburse any fees/expense; a student may incur for the SWAYAM/NPTEL/other approved MOOCs.

13.4 The maximum number of credits that can be transferred by a student shall be limited to forty percent (40%) of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree. However, the grades obtained in the Courses transferred from other Institutions/MOOCs, as mentioned in this Section (13.**Error! Reference source not found.**), shall not be included in the calculation of the CGPA.

14. Structure / Component with Credit Requirements Course Baskets & Minimum Basket wise Credit Requirements

The B.Tech. (Electronics and Communication Engineering) Program Structure (2023-2027) totalling 160 credits. Table 3 summarizes the type of baskets, number of courses under each basket and the associated credits that are mandatorily required for the completion of the Degree.

Table 3: B.Tech. (VLSI) 2023-2027: Summary of Mandatory Courses and Minimum Credit Contribution from various Baskets		
Sl. No.	**Baskets**	**Credit Contribution**
1	SCHOOL CORE (SC)	58
2	PROGRAM CORE (PC)	60
3	DISCIPLINE ELECTIVE (DE)	30
4	OPEN ELECTIVE (OE)	12
	Total Credits	**160 (Minimum)**

In the entire Program, the practical and skill based course component contribute to an extent of approximately 57% out of the total credits of 160 for B.Tech. (VLSI) program of four year's duration.

15. Minimum Total Credit Requirements of Award of Degree

As per the AICTE guidelines, a minimum of 160 credits is required for the award of a B.Tech. degree.

16. Other Specific Requirements for Award of Degree, if any, as prescribed by the Statutory Bodies,

16.1 The award of the Degree shall be recommended by the Board of Examinations and approved by the Academic Council and Board of Management of the University**.**

16.2 A student shall be declared to be eligible for the award of the concerned Degree if she/he:

a. Fulfilled the Minimum Credit Requirements and the Minimum Credits requirements under various baskets;

b. Secure a minimum CGPA of 4.50 in the concerned Program at the end of the Semester/Academic Term in which she/he completes all the requirements for the award of the Degree as specified in Sub-Clause a of Academic Regulations**;**

c. No dues to the University, Departments, Hostels, Library, and any other such Centers/ Departments of the University; and

d. No disciplinary action is pending against her/him.

17. Curriculum Structure – Basket Wise Course List (not Semester Wise)
List of Courses Tabled – aligned to the Program Structure
(Course Code, Course Name, Credit Structure (LTPC), Contact Hours, Course Basket, Type of Skills etc., as applicable).

Table 3.1 : List of School Core Courses (SC)

S.No	Course Code	Course Name	L	T	P	C
1	MAT1001	Calculus and Linear Algebra	3	0	2	4
2	PHY1002	Optoelectronics and Device Physics	2	0	2	3
3	ECE1001	Elements of Electronics Engineering	3	0	2	4
4	ENG1002	Technical English	1	0	2	2
5	PPS1001	Introduction to soft skills	0	0	2	1
6	CSE1004	Problem Solving Using C	1	0	4	3
7	CHE1018	Environmental Science	1	0	2	0
8	PPS1011	Introduction to Verbal Ability	0	1	0	0
9	MAT1003	Applied Statistics	1	0	2	2
10	CIV1008	Basic Engineering Sciences	2	0	0	2

11	MEC1006	Engineering Graphics	2	0	0	2
12	CSE1006	Problem Solving using JAVA	2	0	2	3
13	ENG2001	Advanced English	1	0	2	2
14	PPS1012	Enhancing Personality Through Soft Skills	0	0	2	1
15	ECE2010	Innovative Projects using Arduino	0	0	0	1
16	MAT1002	Transform Techniques, Partial Differential Equations and Their Applications	3	0	0	3
17	CSE2001	Data Structures and Algorithms	3	0	2	4
18	PPS4002	Introduction to Aptitude	0	0	2	1
19	CSE1005	Programming in Python	1	0	4	3
20	ECE2011	Innovative Projects using Rasberry Pi	0	0	0	1
21	MAT2003	Numerical Methods for Engineers	1	0	2	2
22	CSE3216	Mastering Object Oriented Concepts in Python	0	0	2	1
23	PPS4004	Aptitude Training Intermediate	0	0	2	1
24	PIP2001	Capstone Project	-	-	-	4
25	PIP4xxx	Internship	-	-	-	8
					Total No. of Credits	58

Table 3.2 : List of Program Core Courses (PC)

S. No.	Course Code	Course Name	L	T	P	C
1	ECE2004	Network Theory	2	1	0	3
2	CHE1017	Applied Chemistry	1	0	2	2
3	ECE2002	Digital Electronics	2	1	2	4
4	ECE2012	Solid State Electronics	3	0	0	3
5	ECE2013	Digital System Design using HDL	3	0	2	4
6	ECE3109	Signal Processing	3	0	2	4
7	ECE3160	Communication Systems	3	0	2	4
8	ECE3119	Microcontrollers and Computer Architecture	3	0	2	4
9	ECE3044	IC Fabrication Technology	3	0	2	4
10	ECE3173	Introduction to CMOS VLSI Design	3	0	0	3
11	ECE3122	Microelectronics	3	0	0	3
12	ECE3175	Embedded Systems	3	0	0	3
13	ECE3043	Mixed Signal Circuit Design	3	0	0	3
14	ECE3174	Introduction to CMOS VLSI Design Laboratory	0	0	2	1
15	ECE3176	Embedded Systems Laboratory	0	0	2	1
16	ECE3124	VLSI Design Verification	3	0	0	3
17	ECE3177	RF Integrated Circuits and systems	3	0	0	3

18	ECE3050	Design for Testability	3	0	0	3
19	ECE3179	Physical Design and Automation	3	0	0	3
20	ECE3178	RF Integrated Circuits and systems Laboratory	0	0	2	1
21	ECE3180	Physical Design and Automation Laboratory	0	0	2	1
					Total No. of Credits	60

18. Practical / Skill based Courses – Internships / Thesis / Dissertation / Capstone Project Work / Portfolio / Mini project

Practical / Skill based Courses like internship, project work, capstone project, research project / dissertation, and such similar courses, where the pedagogy does not lend itself to a typical L-T-P-C Structure as defined in Clause 5.1 of the Academic Regulations, are simply assigned the number of Credits based on the quantum of work / effort required to fulfill the learning objectives and outcomes prescribed for the concerned Courses. Such courses are referred to as Non-Teaching Credit Courses (NTCC). These Courses are designed to provide students with hands-on experience and skills essential for their professional development. These courses aim to equip students with abilities in problem identification, root cause analysis, problem-solving, innovation, and design thinking through industry exposure and project-based learning. The expected outcomes are first level proficiency in problem solving and design thinking skills to better equip B.Tech. graduates for their professional careers. The method of evaluation and grading for the Practical / Skill based Courses shall be prescribed and approved by the concerned Departmental Academic Committee (refer Annexure A of the Academic Regulations). The same shall be prescribed in the Course Plan.

18.1 Internship

A student may undergo an Internship for a period of 12-14 weeks in an industry / company or academic / research institution during the 7th or 8th Semesters, subject to the following conditions :

18.1.1 The Internship shall be in conducted in accordance with the Internship Policy prescribed by the University from time to time.

18.1.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Internship to a student;

18.1.3 The number of Internships available for the concerned Academic Term. Further, the available number of internships shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the Internship, as stated in Sub-Clause 2.6.1.2 above.

18.1.4 A student may opt for Internship in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the

concerned student takes the responsibility to arrange the Internship on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Internship confirms to the University that the Internship shall be conducted in accordance with the Program Regulations and Internship Policy of the University.

18.1.5 A student selected for an Internship in an industry / company or academic / research institution shall adhere to all the rules and guidelines prescribed in the Internship Policy of the University.

18.2 Project Work

A student may opt to do a Project Work for a period of 4-6 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Internship during the Semester Break between 4th and 5th Semesters or 6th and 7th Semesters, subject to the following conditions:

18.2.1 The Project Work shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

18.2.2 The student may do the project work in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 2.6.2.1). Provided further, that the Industry / Company or academic / research institution offering such project work confirms to the University that the project work will be conducted in accordance with the Program Regulations and requirements of the University.

18.3 Capstone Project

A student may undergo a Capstone Project for a period of 12-14 weeks in an industry / company or academic / research institution in the 7th / 8th Semester as applicable, subject to the following conditions:

18.3.1 The Capstone Project shall be in conducted in accordance with the Capstone Project Policy prescribed by the University from time to time.

18.3.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Capstone Project to a student;

18.3.3 The number of Capstone Project available for the concerned Academic Term. Further, the available number of Capstone Project shall be awarded to the students by the University on the basis of merit using the CGPA secured by

the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the Capstone Project, as stated in Sub-Clause 2.6.3.2 above.

18.3.4 A student may opt for Capstone Project in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the I Capstone Project on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Capstone Project confirms to the University that the Capstone Project shall be conducted in accordance with the Program Regulations and Internship Policy of the University.

18.3.5 A student selected for a Capstone Project in an industry / company or academic / research institution shall adhere to all the rules and guidelines prescribed in the Capstone Project Policy of the University.

18.4 Research Project / Dissertation

A student may opt to do a Research Project / Dissertation for a period of 12-14 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Capstone Project, subject to the following conditions:

18.4.1 The Research Project / Dissertation shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

The student may do the Research Project / Dissertation in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 2.6.4.1). Provided further, that the Industry / Company or academic / research institution offering such Research Project / Dissertation confirms to the University that the Research Project / Dissertation work will be conducted in accordance with the Program Regulations and requirements of the University.

19. List of Discipline Elective Courses under various Specialisations / Stream Basket

Table 3.3 : Discipline Elective Courses

S. No.	Course Code	Course Name	L	T	P	C
General Basket						
1	ECE3015	Measuring Instruments and Sensors	3	0	0	3
2	ECE3016	Electronic Controlled Converters	3	0	0	3
3	ECE3017	Linear Algebra for Communication Engineering	3	0	0	3

Table 3.3 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
4	ECE3018	Engineering Applications using Software Tools	3	0	0	3
5	ECE3019	Python Programming For Electronics Applications	3	0	0	3
6	ECE3020	Computational Intelligence and Machine Learning	3	0	0	3
7	ECE3021	Optoelectronic Materials	3	0	0	3
8	ECE3022	Fundamental s of Photonics	3	0	0	3
9	ECE3023	Wireless Sensor Networks and IoT	3	0	0	3
10	ECE3024	Data Acquisition Techniques	3	0	0	3
11	ECE3025	Artificial Intelligence with Python	3	0	0	3
12	ECE3026	Neural Networks and Deep Learning	3	0	0	3
13	ECE3027	Industrial Automation and Control	3	0	0	3
Signal Processing Basket						
1	ECE3028	Speech Signal Processing	3	0	0	3
2	ECE3029	Digital Image Processing	3	0	0	3
3	ECE3030	Fuzzy Logic and its Engineering Applications	3	0	0	3
4	ECE3031	Applications of Deep Learning	3	0	0	3
5	ECE3032	Multimedia Signal Processing	3	0	0	3
6	ECE3033	Adaptive Signal Processing	3	0	0	3
7	ECE3034	Biomedical Instrumentation	3	0	0	3
8	ECE3035	Biomedical Signal Processing	3	0	0	3
9	ECE3036	Probabilistic Systems analysis	3	0	0	3
10	ECE3037	Audio Signal Processing for Music Applications	3	0	0	3
11	ECE3038	Electronic Music Production	3	0	0	3
12	ECE3039	DSP Processors	3	0	0	3
VLSI and Embedded Systems Basket						
1	ECE3127	Electronic Systems and PCB Design	3	0	0	3
2	ECE3128	VLSI Architecture	3	0	0	3
3	ECE3129	Digital Control Systems	3	0	0	3
4	ECE3130	Electromagnetic Theory and Transmission Lines	3	0	0	3
5	ECE3131	Analog and Digital Communication	3	0	0	3
6	ECE3132	ASIC Design	3	0	0	3
7	ECE3133	Semiconductor Device Modeling	3	0	0	3
8	ECE3134	VLSI DSP Architectures	3	0	0	3
9	ECE3135	Synthesis and Optimization of Digital Circuits	3	0	0	3
10	ECE3136	VLSI Wireless Communication	3	0	0	3
11	ECE3137	Analog VLSI Design	3	0	0	3
12	ECE3138	VLSI Interconnects	3	0	0	3
13	ECE3140	Static Timing Analysis	3	0	0	3

Table 3.3 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
14	ECE3141	System Verilog	3	0	0	3
15	ECE3142	Mixed Signal Design	3	0	0	3
16	ECE3145	Advanced VLSI and SoC Design	3	0	0	3
17	ECE3146	VLSI Algorithms and Design	3	0	0	3
18	ECE3147	Hardware Platforms for AI/ML Deployment	3	0	0	3
19	ECE3152	Network System Design	3	0	0	3
20	ECE3041	Real Time Systems	3	0	0	3
21	ECE3042	MEMS and Nanotechnology	3	0	0	3
22	ECE3045	Sensor Technology	3	0	0	3
23	ECE3046	Low power VLSI Design	3	0	0	3
24	ECE3047	CAD for VLSI	3	0	0	3
25	ECE3048	FPGA Design for Embedded Systems	3	0	0	3
26	ECE3049	Developing Secure Embedded Systems	3	0	0	3
27	ECE3052	Introduction to Embedded Machine Learning	3	0	0	3
Data Transfer Technologies Basket						
1	ECE3053	Data Communication and Networking	3	0	0	3
2	ECE3054	Mobile Communication	3	0	0	3
3	ECE3055	Satellite Communication	3	0	0	3
4	ECE3056	Wireless Communication and Networks	3	0	0	3
5	ECE3057	Radar Engineering	3	0	0	3
6	ECE3058	RF Engineering	3	0	0	3
7	ECE3059	Security in Computer Networks	3	0	0	3
8	ECE3060	Wireless Adhoc Networks	3	0	0	3
9	ECE3061	Optical Communication	3	0	0	3
AI & Wearable Technologies Basket						
1	ECE3062	Fundamentals of Wearable Sensing	3	0	0	3
2	ECE3063	Wearable Devices and Its Applications	3	0	0	3
3	ECE3064	Embedded Platforms for Wearables	3	0	0	3
4	ECE3065	RFID and Flexible Sensors	3	0	0	3
5	ECE3066	Wireless Technologies for Wearables	3	0	0	3
6	ECE3067	Wearable Internet of Things (WIoT)	3	0	0	3
7	ECE3068	Embedded Intelligence in WIoT	3	0	0	3
8	ECE3069	Flexible Electronics And Sensors	3	0	0	3
9	ECE3070	AI & Digital Health	3	0	0	3
10	ECE3071	Wearable and Ubiquitous Computing	3	0	0	3
11	ECE3072	Secure Wearable Internet of Things	3	0	0	3

12	ECE3073	Wearable Prosthetics and Robots	3	0	0	3
13	ECE3074	Applications of Brain Computer Interfaces	3	0	0	3
IoT & Sensor Technologies Basket						
1	ECE3075	IoT: Architecture and Protocols	3	0	0	3
2	ECE3076	IoT Platforms and Application Development	3	0	0	3
3	ECE3077	Wireless Protocols for IoT	3	0	0	3
4	ECE3078	IoT and Cloud Computing	3	0	0	3
5	ECE3079	Fog Computing	3	0	0	3
6	ECE3080	IoT Edge Nodes and its Applications	3	0	0	3
7	ECE3081	Security and Privacy in Traditional IoT Systems	3	0	0	3
8	ECE3082	Data Science for IoT	3	0	0	3
9	ECE3083	Hardware and Software Architectures for IoT Systems	3	0	0	3
10	ECE3084	Mobile App Development for IoT	3	0	0	3
11	ECE3085	Security and Privacy in Edge Native Solutions	3	0	0	3
12	ECE3086	Industrial Internet of Things (IIoT)	3	0	0	3
13	ECE3087	IoT Robots	3	0	0	3
14	ECE3088	Internet of Medical Things (IoMT)	3	0	0	3

20. List of Open Electives to be offered by the School / Department (Separately for ODD and EVEN Semesters.

Table 3.4 : Open Elective Courses						
Sl. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Chemistry Basket						
1	CHE1003	Fundamentals of Sensors	3	0	0	3
2	CHE1004	Smart materials for IOT	3	0	0	3
3	CHE1005	Computational Chemistry	2	0	0	2
4	CHE1006	Introduction to Nano technology	3	0	0	3
5	CHE1007	Biodegradable electronics	2	0	0	2
6	CHE1008	Energy and Sustainability	2	0	0	2
7	CHE1009	3D printing with Polymers	2	0	0	2
8	CHE1010	Bioinformatics and Healthcare IT	2	0	0	2
9	CHE1011	Chemical and Petrochemical catalysts	3	0	0	3
10	CHE1012	Introduction to Composite materials	2	0	0	2
11	CHE1013	Chemistry for Engineers	3	0	0	3
12	CHE1014	Surface and Coatings technology	3	0	0	3
13	CHE1015	Waste to Fuels	2	0	0	2
14	CHE1016	Forensic Science	3	0	0	3
Civil Engineering Basket						
1	CIV1001	Disaster mitigation and management	3	0	0	3
2	CIV1002	Environment Science and Disaster Management	3	0	0	3

3	CIV2001	Sustainablility Concepts in Engineering	3	0	0	3
4	CIV2002	Occupational Health and Safety	3	0	0	3
5	CIV2003	Sustainable Materials and Green Buildings	3	0	0	3
6	CIV2004	Integrated Project Management	3	0	0	3
7	CIV2005	Enviornmental Impact Assessment	3	0	0	3
8	CIV2006	Infrastructure Systems for Smart Cities	3	0	0	3
9	CIV2044	Geospatial Applications for Engineers	2	0	2	3
10	CIV2045	Environmental Meteorology	3	0	0	3
11	CIV3046	Project Problem Based Learning	3	0	0	3
12	CIV3059	Sustainability for Professional Practice	3	0	0	3
Commerce Basket						
1	COM2001	Introduction to Human Resource Management	2	0	0	2
2	COM2002	Finance for Non Finance	2	0	0	2
3	COM2003	Contemporay Management	2	0	0	2
4	COM2004	Introduction to Banking	2	0	0	2
5	COM2005	Introduction to Insurance	2	0	0	2
6	COM2006	Fundamentals of Management	2	0	0	2
7	COM2007	Basics of Accounting	3	0	0	3
Computers Basket						
1	CSE2002	Programming in Java	2	0	2	3
2	CSE2003	Social Network Analytics	3	0	0	3
3	CSE2004	Python Application Programming	2	0	2	3
4	CSE2005	Web design fundamentals	2	0	2	3
5	CSE3111	Artificial Intelligence : Search Methods For Problem Solving	3	0	0	3
6	CSE3112	Privacy And Security In Online Social Media	3	0	0	3
7	CSE3113	Computational Complexity	3	0	0	3
8	CSE3114	Deep Learning for Computer Vision	3	0	0	3
9	CSE3115	Learning Analytics Tools	3	0	0	3
Design Basket						
1	DES1001	Sketching and Painting	0	0	2	1
2	DES1002	Innovation and Creativity	2	0	0	2
3	DES1121	Introduction to UX design	1	0	2	2
4	DES1122	Introduction to Jewellery Making	1	0	2	2
5	DES1124	Spatial Stories	1	0	2	2
6	DES1125	Polymer Clay	1	0	2	2
7	DES2001	Design Thinking	3	0	0	3
8	DES1003	Servicability of Fashion Products	1	0	2	2
9	DES1004	Choices in Virtual Fashion	1	0	2	2
10	DES1005	Fashion Lifestyle and Product Diversity	1	0	2	2
11	DES1006	Colour in Everyday Life	1	0	2	2
12	DES2080	Art of Design Language	3	0	0	3
13	DES2081	Brand Building in Design	3	0	0	3
14	DES2085	Web Design Techniques	3	0	0	3
15	DES2089	3D Modeling for Professionals	1	0	4	3

16	DES2090	Creative Thinking for Professionals	3	0	0	3
17	DES2091	Idea Formulation	3	0	0	3
Electrical and Electronics Basket						
1	EEE1002	IoT based Smart Building Technology	3	0	0	3
2	EEE1003	Basic Circuit Analysis	3	0	0	3
3	EEE1004	Fundamentals of Industrial Automation	3	0	0	3
4	EEE1005	Electric Vehicles & Battery Technology	3	0	0	3
5	EEE1006	Smart Sensors for Engineering Applications	3	0	0	3
Electronics and Communication Basket						
1	ECE1003	Fundamentals of Electronics	3	0	0	3
2	ECE3089	Artificial Neural Networks	3	0	0	3
3	ECE3090	Digital System Design using VERILOG	3	0	0	3
4	ECE3091	Mathematical Physics	3	0	0	3
5	ECE3092	Photonic Integrated Circuits	3	0	0	3
6	ECE3093	Machine learning for Music Information Retrieval	3	0	0	3
7	ECE3094	Video Processing and Computer Vision	3	0	0	3
8	ECE3095	Blockchain and Cryptocurrency Technologies	3	0	0	3
9	ECE3096	Natural Language Processing	3	0	0	3
10	ECE3097	Smart Electronics in Agriculture	3	0	0	3
11	ECE3098	Environment Monitoring Systems	3	0	0	3
12	ECE3099	Modern Wireless Communication with 5G	3	0	0	3
13	ECE3100	Underwater Communication	3	0	0	3
14	ECE3101	Printed Circuit Board Design	3	0	0	3
15	ECE3102	Consumer Electronics	3	0	0	3
16	ECE3103	Product Design of Electronic Equipment	3	0	0	3
17	ECE3104	Vehicle to Vehicle Communication	3	0	0	3
18	ECE3105	Wavelets and Filter Banks	3	0	0	3
19	ECE3106	Introduction to Data Analytics	3	0	0	3
20	ECE3107	Machine Vision for Robotics	3	0	0	3
English Basket						
1	ENG1008	Indian Literature	2	0	0	2
2	ENG1009	Reading Advertisement	3	0	0	3
3	ENG1010	Verbal Aptitude for Placement	2	0	2	3
4	ENG1011	English for Career Development	3	0	0	3
5	ENG1012	Gender and Society in India	2	0	0	2
6	ENG1013	Indian English Drama	3	0	0	3
7	ENG1014	Logic and Art of Negotiation	2	0	2	3
8	ENG1015	Professional Commuication Skills for Engineers	1	0	0	1
DSA Basket						
1	DSA2001	Spirituality for Health	2	0	0	2
2	DSA2002	Yoga for Health	2	0	0	2
3	DSA2003	Stress Management and Well Being	2	0	0	2
Kannada Basket						
1	KAN1001	Kali Kannada	1	0	0	1

2	KAN1003	Kannada Kaipidi	3	0	0	3
3	KAN2001	Thili Kannada	1	0	0	1
4	KAN2003	Pradharshana Kale	1	0	2	2
5	KAN2004	Sahithya Vimarshe	2	0	0	2
6	KAN2005	Anuvadha Kala Sahithya	3	0	0	3
7	KAN2006	Vichara Manthana	3	0	0	3
8	KAN2007	Katha Sahithya Sampada	3	0	0	3
9	KAN2008	Ranga Pradarshana Kala	3	0	0	3
Foreign Language Basket						
1	FRL1004	Introduction of French Language	2	0	0	2
2	FRL1005	Fundamentals of French	2	0	0	2
3	FRL1009	Mandarin Chinese for Beginners	3	0	0	3
Law Basket						
1	LAW1001	Introduction to Sociology	2	0	0	2
2	LAW2001	Indian Heritage and Culture	2	0	0	2
3	LAW2002	Introdcution to Law of Succession	2	0	0	2
4	LAW2003	Introduction to Company Law	2	0	0	2
5	LAW2004	Introduction to Contracts	2	0	0	2
6	LAW2005	Introduction to Copy Rights Law	2	0	0	2
7	LAW2006	Introduction to Criminal Law	2	0	0	2
8	LAW2007	Introduction to Insurance Law	2	0	0	2
9	LAW2008	Introduction to Labour Law	2	0	0	2
10	LAW2009	Introduction to Law of Marriages	2	0	0	2
11	LAW2010	Introduction to Patent Law	2	0	0	2
12	LAW2011	Introduction to Personal Income Tax	2	0	0	2
13	LAW2012	Introduction to Real Estate Law	2	0	0	2
14	LAW2013	Introduction to Trademark Law	2	0	0	2
15	LAW2014	Introduction to Competition Law	3	0	0	3
16	LAW2015	Cyber Law	3	0	0	3
17	LAW2016	Law on Sexual Harrassment	2	0	0	2
18	LAW2017	Media Laws and Ethics	2	0	0	2
Mathematics Basket						
1	MAT2008	Mathematical Reasoning	3	0	0	3
2	MAT2014	Advanced Business Mathematics	3	0	0	3
3	MAT2041	Functions of Complex Variables	3	0	0	3
4	MAT2042	Probability and Random Processes	3	0	0	3
5	MAT2043	Elements of Number Theory	3	0	0	3
6	MAT2044	Mathematical Modelling and Applications	3	0	0	3
Mechanical Basket						
1	MEC1001	Fundamentals of Automobile Engineering	3	0	0	3
2	MEC1002	Introduction to Matlab and Simulink	3	0	0	3
3	MEC1003	Engineering Drawing	1	0	4	3
4	MEC2001	Renewable Energy Systems	3	0	0	3
5	MEC2002	Operations Research & Management	3	0	0	3

6	MEC2003	Supply Chain Management	3	0	0	3
7	MEC2004	Six Sigma for Professionals	3	0	0	3
8	MEC2005	Fundamentals of Aerospace Engineering	3	0	0	3
9	MEC2006	Safety Engineering	3	0	0	3
10	MEC2007	Additive Manufacturing	3	0	0	3
11	MEC3069	Engineering Optimisation	3	0	0	3
12	MEC3070	Electronics Waste Management	3	0	0	3
13	MEC3071	Hybrid Electric Vehicle Design	3	0	0	3
14	MEC3072	Thermal Management of Electronic Appliances	3	0	0	3
15	MEC3200	Sustainable Technologies and Practices	3	0	0	3
16	MEC3201	Industry 4.0	3	0	0	3
Petroleum Basket						
1	PET1005	Geology for Engineers	2	0	0	2
2	PET1006	Overview of Energy Industry	2	0	0	2
3	PET1007	Introduction to Energy Trading and Future Options	2	0	0	2
4	PET1008	Sustainable Energy Management	2	0	0	2
5	PET2026	Introduction to Computational Fluids Dynamics	3	0	0	3
6	PET2028	Polymer Science and Technology	3	0	0	3
7	PET2031	Overview of Material Science	3	0	0	3
8	PET2032	Petroleum Economics	3	0	0	3
Physics Basket						
1	PHY1003	Mechanics and Physics of Materials	3	0	0	3
2	PHY1004	Astronomy	3	0	0	3
3	PHY1005	Game Physics	2	0	2	3
4	PHY1006	Statistical Mechanics	2	0	0	2
5	PHY1007	Physics of Nanomaterials	3	0	0	3
6	PHY1008	Adventures in nanoworld	2	0	0	2
7	PHY2001	Medical Physics	2	0	0	2
8	PHY2002	Sensor Physics	1	0	2	2
9	PHY2003	Computational Physics	1	0	2	2
10	PHY2004	Laser Physics	3	0	0	3
11	PHY2005	Science and Technology of Energy	3	0	0	3
12	PHY2009	Essentials of Physics	2	0	0	2
Management Basket						
1	MGT1001	Introduction to Psychology	3	0	0	3
2	MGT1002	Business Intelligence	3	0	0	3
3	MGT1003	NGO Management	3	0	0	3
4	MGT1004	Essentials of Leadership	3	0	0	3
5	MGT1005	Cross Cultural Communication	3	0	0	3
6	MGT2001	Business Analytics	3	0	0	3
7	MGT2002	Organizational Behaviour	3	0	0	3
8	MGT2003	Competitive Intelligence	3	0	0	3
9	MGT2004	Development of Enterprises	3	0	0	3
10	MGT2005	Economics and Cost Estimation	3	0	0	3

11	MGT2006	Decision Making Under Uncertainty	3	0	0	3
12	MGT2007	Digital Entrepreneurship	3	0	0	3
13	MGT2008	Econometrics for Managers	3	0	0	3
14	MGT2009	Management Consulting	3	0	0	3
15	MGT2010	Managing People and Performance	3	0	0	3
16	MGT2011	Personal Finance	3	0	0	3
17	MGT2012	E Business for Management	3	0	0	3
18	MGT2013	Project Management	3	0	0	3
19	MGT2014	Project Finance	3	0	0	3
20	MGT2015	Engineering Economics	3	0	0	3
21	MGT2016	Business of Entertainment	3	0	0	3
22	MGT2017	Principles of Management	3	0	0	3
23	MGT2018	Professional and Business Ethics	3	0	0	3
24	MGT2019	Sales Techniques	3	0	0	3
25	MGT2020	Marketing for Engineers	3	0	0	3
26	MGT2021	Finance for Engineers	3	0	0	3
27	MGT2022	Customer Relationship Management	3	0	0	3
28	MGT2023	People Management	3	0	0	3
Media Studies Basket						
1	BAJ3050	Corporate Filmmaking and Film Business	0	0	4	2
2	BAJ3051	Digital Photography	2	0	2	3
3	BAJ3055	Introduction to News Anchoring and News Management	0	0	2	1
Research URE Basket						
1	URE2001	University Research Experience	-	-	-	3
2	URE2002	University Research Experience	-	-	-	0

21.List of MOOC (NPTEL) Courses

21.1 NPTEL - Discipline Elective Courses for B. Tech. (VLSI)

Sl. No.	Course ID	Course Name	Duration
1	noc25-cs22	Deep Learning for Natural Language Processing	12 Weeks
2	noc25-ee13	Computer Vision And Image Processing - Fundamentals And Applications	12 Weeks
3	noc25-ee25	Digital VLSI Testing	12 Weeks
4	noc25-ee31	Embedded Sensing, Actuation and Interfacing Systems	12 Weeks
5	noc25-ee58	Optical Fiber Sensors	12 Weeks
6	noc25-ee62	Physics of Nanoscale Devices	12 Weeks
7	noc25-ee73	RF Transceiver Design	12 Weeks

8	noc25-ee79	Smart Grid: Basics to Advanced Technologies	12 Weeks
9	noc25-ee83	VLSI Physical Design with Timing Analysis	12 Weeks
10	noc25-ee75	Semiconductor Devices for Next Generation Field Effect Transistors (More than Moore): A Physics Perspective	12 Weeks

21.2 NPTEL - Open Elective Courses for B. Tech. (VLSI)

Sl. No.	Course ID	Course Name	Duration
1	noc25-cs04	Affective Computing	12 Weeks
2	noc25-cs08	Blockchain and its Applications	12 Weeks
3	noc25-cs11	Cloud Computing	12 Weeks
4	noc25-cs32	Foundations of Cyber Physical Systems	12 Weeks
5	noc25-cs38	Human Computer Interaction (In English)	12 Weeks
6	noc25-cs51	Natural Language Processing	12 Weeks
7	noc25-cs45	Introduction to Large Language Models (LLMs)	12 Weeks
8	noc25-cs02	Advanced Computer Networks	12 Weeks
9	noc25-cs70	Theory of Computation	12 Weeks

22. Recommended Semester Wise Course Structure / Flow including the Programme / Discipline Elective Paths / Options

Semester 1										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	MAT1001	Linear Algebra and Calculus	3	0	2	4	5	School Core	F	
2	PHY1002	Optoelectronics and Device Physics	2	0	2	3	4	School Core	F	
3	ECE1006	Basic Electronics Engineering	3	0	2	4	5	School Core	F	
4	ENG1001 / ENG1002	Foundation English / Technical English	1	0	2	2	3	School Core	F/S	
5	ECE2004	Network Theory	2	1	0	3	3	Program Core	F	
6	PPS1001	Introduction to soft skills	0	0	2	1	2	School Core	S	HP
7	CSE1004	Problem Solving using C	1	0	4	3	5	School Core	S	

8	CHE1018	Environmental Science	1	0	2	0	3	School Core	F	ES
9	PPS1011	Introduction to Verbal Ability	0	1	0	0	1	School Core	S/EM	
		TOTAL				20	31			

Semester 2										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	MAT1003	Applied Statistics	1	0	2	2	3	School Core	F	
2	CHE1017	Applied Chemistry	1	0	2	2	3	Program Core	F	
3	CIV1008	Basic Engineering Sciences	2	0	0	2	2	School Core	F	
4	MEC1006	Engineering Graphics	2	0	0	2	2	School Core	S	
5	CSE1006	Problem Solving using JAVA	2	0	2	3	4	School Core	S/EM	
6	ENG1002 / ENG2001	Technical English / Advanced English	1	0	2	2	3	School Core	S	
7	ECE2001	Analog Electronics	2	1	2	4	5	Program Core	F	
8	PPS1012	Enhancing Personality Through Soft Skills	0	-	2	1	2	School Core	S	HP
9	ECE2010	Innovative Projects Using Arduino	-	-	-	1	-	School Core	S	
		TOTAL				19	24	-	-	-

Semester 3										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	MAT1002	Transform Techniques, Partial Differential Equations and Their Applications	3	0	0	3	3	School Core	F	
2	CSE2001	Data Structures and Algorithms	3	0	2	4	5	School Core	F	
3	ECE2012	Solid State Electronics	3	0	0	3	5	Program Core	F	
4	ECE2013	Digital System Design using HDL	3	0	2	4	3	Program Core	F	

5	ECE3109	Signal Processing	3	0	2	4	5	Program Core	F	
6	PPS4002	Introduction to Aptitude	0	0	2	1	2	School Core	S/EM	HP/GS
7	CSE1005	Programming in Python	1	0	4	3	5	School Core	S	
8	ECE2011	Innovative Projects using Rasberry Pi	0	0	0	1	0	School Core	S	
		TOTAL				23	28	-	-	-

Semester 4										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**						**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**	**BASKET**		
1	MAT2003	Numerical Methods for Engineers	1	0	2	2	3	School Core	F	
2	ECE3160	Communication Systems	3	0	2	4	5	Program Core	F	
3	ECE3119	Microcontrollers and Computer Architecture	3	0	2	4	5	Program Core	F	
4	ECE3044	IC Fabrication Technology	3	0	2	4	5	Program Core	F	
5	ECEXXXX	Discipline Elective - I	3	0	0	3	3	Discipline Elective	EM	
6	ECEXXXX	Discipline Elective - II	3	0	0	3	3	Discipline Elective	Em	
7	xxxXXXX	Open Elective - I	3	0	0	3	3	Open Elective	S/EM/ EN	
8	CSE3216	Mastering Object Oriented Concepts in Python	0	0	2	1	2	School Core	S/EM	HP/GS
		TOTAL				25	31	-	-	-

Semester 5										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**						**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**	**BASKET**		
1	ECE3173	Introduction to CMOS VLSI Design	3	0	0	3	3	Program Core	F	F
2	ECE3122	Microelectronics	3	0	0	3	3	Program Core	F/EM	F/EM
3	ECE3175	Embedded Systems	3	0	0	3	3	Program Core	F	F
4	ECE3043	Mixed Signal Circuit Design	3	0	0	3	3	Program Core	F/EM	F/EM
5	ECEXXXX	Discipline Elective -	3	0	0	3	3	Discipline	EM	EM

		III						Elective		
6	ECEXXXX	Discipline Elective - IV	3	0	0	3	3	Discipline Elective	EM	EM
7	MGTXXXX	Open Elective - II (Course from Management Basket)	3	0	0	3	3	Open Elective	S/EM/EN	S/EM/EN
8	ECE3174	Introduction to CMOS VLSI Design Laboratory	0	0	2	1	2	Program Core	F	
9	ECE3176	Embedded Systems Laboratory	0	0	2	1	2	Program Core	F	
		TOTAL				23	25	-	-	-

Semester 6										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	ECE3124	VLSI Design Verification	3	0	0	3	3	Program Core	F/EM	
2	ECE3177	RF Integrated Circuits and systems	3	0	0	3	3	Program Core	F/ EM/ EN	
3	ECE3050	Design for Testability	3	0	0	3	3	Program Core	F/ EM	
4	ECE3179	Physical Design and Automation	3	0	0	3	3	Program Core	F/EM	
5	ECEXXXX	Discipline Elective - V	3	0	0	3	3	Discipline Elective	EM	
6	ECEXXXX	Discipline Elective - VI	3	0	0	3	3	Discipline Elective	EM	
7	xxxXXXX	Open Elective - III (Course from Management Basket)	3	0	0	3	3	Open Elective	S/EM/EN	
8	ECE3178	RF Integrated Circuits and systems Laboratory	0	0	2	1	2	Program Core	F/EM	
9	ECE3180	Physical Design and Automation Laboratory	0	0	2	1	2	Program Core		
		TOTAL				23	25	-	-	-

Semester 7										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	ECEXXXX	Discipline Elective - VII	3	0	0	3	3	Discipline Elective	EM	
2	ECEXXXX	Discipline Elective -	3	0	0	3	3	Discipline	EM	

		VIII						Elective		
3	ECEXXXX	Discipline Elective - IX	3	0	0	3	3	Discipline Elective	EM	
4	ECEXXXX	Discipline Elective - IX	3	0	0	3	3	Discipline Elective	EM	
5	xxxXXXX	Open Elective - IV	3	0	0	3	3	Open Elective	EM	
6	PIP2001	Capstone Project	-	-	-	4	0	School Core	S/EM/EN	
		TOTAL				19	15	-	-	-

Semester 8										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	PIP4xxx	Internship	-	-	-	8	0	School Core	F/EM	
		TOTAL				8	0	-	-	-

23. Course Catalogue

Course Catalogue of all Courses Listed including the Courses Offered by other School / Department and Discipline / Programme Electives – Course Code, Course Name, Prerequisite, Anti-requisite, Course Description, Course Outcome, Course Content (with Blooms Level, CO, No. of Contact Hours), Reference Resources.

COURSE DESCRIPTION AND SYLLABUS SCHOOL CORE

Course Code: MAT1001	**Course Title: Calculus and Linear Algebra** **Type of Course:1] School Core Lab Integrated**	**L-T- P- C**	**3**	**1**	**0**	**4**
Version No.	2.0					
Course Pre-requisites	Basic Concepts of Limits, Differentiation, Integration					
Anti-requisites	**NIL**					
Course Description	The course focuses on the concepts of calculus and linear algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature.					
Course Objective	The objective of the course is to **familiarize the learners with the concepts of "**CALCULUS AND LINEAR ALGEBRA" **and attain <u>Skill Development</u> through problem solving techniques**.					
Course Out Comes	On successful completion of the course the students shall be able to: 1) Comprehend the knowledge of applications of matrix principles. 2) Understand the concept of partial derivatives and their applications. 3) Apply the principles of integral calculus to evaluate integrals. 4) Adopt the various analytical methods to solve differential equations.					
Course Content:						
Module 1	**Linear Algebra**					**16 Classes**
Review: Types of matrices, elementary transformations, **Linear Algebra:** Echelon form, rank of a matrix, consistency and solution of system of linear equations - Gauss elimination method, Gauss-Jordan method. Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms. Engineering Applications of Linear Algebra.						
Module 2	**Partial Derivatives**					**14 CLASSES**
Review: Differential calculus with single variable. **Differential Calculus:** Partial differentiation, Homogeneous functions and Euler's theorem, Total derivative, Change of variables, Jacobians, Partial differentiation of implicit functions, Taylor's series for functions of two variables, Maxima and minima of functions of two variables, Lagrange's method of undetermined multipliers. Engineering Applications of partial derivatives.						

Module 3	**Integral calculus**				**12 Classes**

Review: Integral calculus for single integrals.

Integral calculus:

Multiple Integrals- Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves, evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical polar co-ordinates.

Beta and Gamma functions–inter-relation-evaluation of integrals using gamma and beta functions. Evaluate double & triple integrals.

Module 4	**Differential Equations**	**Assignment**		**Programming**	**16 Classes**

Definition, types of differential equations, order and degree, Linear Differential Equations, Bernoulli's Differential Equation, Exact and Non - Exact Differential Equations.

Higher order Differential Equation with constant coefficients and with right hand side of the form eax, sinax, cosax, eaxf(x), xnf(x) etc., Linear equations with variable coefficients such as Cauchy Equation and Lagrange's Equation, Method of Variation of Parameters. Engineering applications of differential equations.

Targeted Application & Tools that can be used:

The contents of this course have direct applications in most of the core engineering courses for problem formulations, Problem Solution and system Design.

Tools Used: Python.

Assignment:

1. List at least 3 sets of Matrix Applications concerning the respective branch of Engineering and obtain the solution using C Programming/Python.
2. Select any one simple differential equation pertaining to the respective branch of engineering, identify the dependent and independent variable – Obtain the solution and compare the solution sets by varying the values of the dependent variable.

Text Book

1. Sankara Rao, Introduction to Partial differential equations, Prentice Hall of India, edition, 2011
2. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.

References:

1. Victor Henner, Tatyana Belozerova, Mickhail Khenner, Ordinary and Partial Differential Equations, CRC Press, Edition, 2013.
2. Walter Ledermann, Multiple integrals, Springer, 1st edition
3. Lay, Linear Algebra ansd its applications, 3rd Ed., 2002, Pearson Education India.
4. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition
5. MatLab usage manual

E-resources/ Web links:

1. https://nptel.ac.in/courses/109104124
2. https://nptel.ac.in/courses/111106051
3. https://nptel.ac.in/courses/111102137
4. https://www.cuemath.com/learn/mathematics/algebra-vs-calculus/
5. https://stanford.edu/~shervine/teaching/cs-229/refresher-algebra-calculus
6. https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/linear-algebra/
7. https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html
8. https://www.scu.edu.au/study-at-scu/units/math1005/2022/

Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of calculus and linear algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature. The lab sessions associated with the course are concerned with acquiring an ability to use the MATLAB software. for **Skill Development through** Experiential Learning **methodologies.** This is attained through assessment

component mentioned in course handout.	
Catalogue prepared by	Dr Veeresh A Sajjanara and Dr V Nagendramma
Recommended by the Board of Studies on	13th BOS held on 04/01/2025
Date of Approval by the Academic Council	24th ACM held in 3rd August 2024

Course Code: PHY1002	**Course Title: Optoelectronics and Device Physics** **Type of Course:1] School Core Lab Integrated**	**L-T- P- C**	**2**	**0**	**2**	**3**
Version No.	1.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to understand the fundamentals, working and applications of optoelectronic devices and to develop the basic abilities to appreciate the applications of advanced microscopy and quantum computers. The course develops the critical thinking, experimental and analytical skills. The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to use the concepts for technological applications. The laboratory tasks aim to develop following skills:					
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Optoelectronics and device physics "and attain **Skill Development** through **Experiential Learning** techniques					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Describe the concepts of semiconductors, magnetic materials and superconductors. CO2: Apply the concept of materials in the working of optoelectronic and magnetic devices. CO3: Discuss the quantum concepts used in advanced microscopy and quantum computers. CO4: Explain the applications of lasers and optical fibers in various technological fields. CO5: Interpret the results of various experiments to verify the concepts used in optoelectronics and advanced devices.					
Course Content:						
Module 1	**Fundamentals of Materials.**	Assignment			**07 Classes**	
Topics: Concept of energy bands, charge carriers, carrier concentration, concept of Fermi level, Hall effect, Superconductors: Josephson effect.						
Module 2	**Advanced Devices and applications**	**Assignment**			**08 CLASSES**	
Topics: p-n junctions, Zener diode, transistor characteristics, Optoelectronic devices, Solar cells, I-V characteristics, and LEDs						
Module 3	**Quantum concepts and Applications**	**Term paper**			**08 Classes**	
Topics: Planck's quantum theory, applications of Quantum theory: de-Broglie hypothesis, matter waves, properties. De-Broglie wavelength associated with an electron. Heisenberg's uncertainty principle						
Module 4	**Lasers and Optical fibers**	**Term paper**			**07 Classes**	
Topics: Interactions of radiations with matter, Characteristics of laser, conditions and requisites of laser, Modern day applications of laser: LIDAR, LASIK, Cutting, Welding and						

Drilling.

Principle of optical fibers, Numerical aperture and acceptance angle (Qualitative), Attenuation, Applications: Point to point communication with block diagram, application of optical fibers in endoscopy.

Targeted Application & Tools that can be used:

1. Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM.
2. Origin, excel and Mat lab soft wares for programming and data analysis.

Assignment:

- Midterm exam
- Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)
- Quiz
- End Term Exam
- Self-Learning

1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons.
2. Write a report on importance of quantum entanglement in supercomputers

Text Book

1. Engineering Physics by Avadhanalu, Revised edition, S. Chand Publications,2018.

References:

1. Elementary Solid state Physics: Principles and Applications by M.A. Omar, 1st Edition, Pearson Publications, 2002.
2. Principles of Quantum Mechanics by R Shankar, 2nd edition, springer Publications, 2011.
3. Optoelectronics: An Introduction by John Wilson and John Hawkes, 3rd edition, Pearson Publications, 2017
4. Engineering Physics by Gaur and Gupta, Dhanpat Rai Publications, 2012.
5. Introduction to Quantum Mechanics, David J Griffiths, Cambridge University Press, 2019

E-resources/ Web links:

1.https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=553045&site=ehost-live
2.https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=833068&site=ehost-live
3.https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=323988&site=ehost-live
4.https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1530910&site=ehost-live
5.https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=486032&site=ehost-live

Topics relevant to SKILL DEVELOPMENT:

amentals of materials, Lasers and optical fibers. for Skill Development through Participative Learning Techniques. This is attained through the Assignment/ Presentation as mentioned in the assessment component in course handout..

Catalogue prepared by	Dr. Anindita, Dr. Sivasankar Reddy, Dr. Naveen C S, Dr. Mohan kumar Naidu, Dr. Deepthi P R, Dr. Mahaboob Pasha, Dr. Ranjeth Kumar Reddy, Dr. Pradeep Bhaskar, Dr. G. Srinivas Reddy, Dr. Saurav Kumar Kajli, Dr. Charan Prasanth
Recommended by the Board of Studies on	12th BOS held on 04/07/2024
Date of Approval by the Academic Council	24th ACM held in 3rd August 2024

Course Code: CSE1006	**Course Title:** Problem Solving using JAVA **Type of Course:** Theory and Lab Integrated	**L-T- P- C**	1	0	4	3
Version No.	2.0					
Course Pre-requisites						
Anti-requisites	Nil					
Course Description	This course introduces the core concepts of object-oriented programming. This course has theory and lab component which emphasizes on understanding the implementation and application of object-oriented programming paradigm. It helps the student to build real time secure applications by applying these concepts and also for effective problem solving. The students interpret and understand the need for object oriented programming to build applications.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Problem-Solving using JAVA and attain **SKILL DEVELOPMENT** through **EXPERIENTIAL LEARNING** techniques					
Course Out Comes	**On successful completion of the course the students shall be able to:** **CO1:** Describe the basic programming concepts. [Understand] **CO2:** Apply the concept of classes, objects and methods to solve problems. [Application] **CO3:** Apply the concept of arrays and strings. [Apply] **CO4:** Implement inheritance and polymorphism building secure applications. [Apply] **CO5:** Apply the concepts of interface and error handling mechanism. [Apply]					
Course Content:						
Module 1	**Basic Concepts of Programming and Java**	Assignment	Problem Solving	**15 Sessions)**		
Topics: Introduction to Principles of Programming: Process of Problem Solving, Java program structure, Download Eclipse IDE to run Java programs, Sample program, Data types, Identifiers, Variables, Constants in java, Operators, Assignments and Expression, Basic Input/ Output functions, Control Statements: Branching and Looping.						
Module 2	**Classes, objects, methods and Constructors**	Assignment	Problem Solving	**17 Sessions (L3 + P14)**		
Topics: Classes, Objects and Methods: Introduction to object Oriented Principles, defining a class, adding data members and methods to the class, access specifiers, instantiating objects, reference variable, accessing class members and methods. Static Polymorphism: Method overloading, constructors, constructor overloading, this keyword, static keyword, Nested classes, Accessing members in nested classes.						
Module 3	**Arrays, String and String buffer**	Assignment	Problem Solving	**13 Sessions (L3 + P10)**		
Topics: Arrays: Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Array of objects. String: Creation & Operation. String builder class, methods in String Buffer.						
Module 4	**Inheritance and Polymorphism**	Assignment	Problem Solving	**17 Sessions (L3 + P14)**		
Topics: Inheritance: Defining a subclass, Types of Inheritance, super keyword. Dynamic Polymorphism: Method overriding. Final keyword: with data members, with member functions and with class. Abstract keyword: with data members, with member functions and with class, Exception handling.						

Module 5	**Input & Output Operation in Java**	Assignment	Problem Solving	**13 Sessions (L3 + P10)**

Input/output Operation in Java(java.io Package), Streams and the new I/O Capabilities, Understanding Streams, working with File Object, File I/O Basics, Reading and Writing to Files, Buffer and Buffer Management, Read/Write Operations with File Channel, Serializing Objects, Observer and Observable Interfaces.

P1: Programming Exercises on Basic Concepts.

LEVEL 1: Discuss about datatypes and variables.

LEVEL 2: Demonstrate a simple java program

P2: Programming Exercises on Basic Concepts.

LEVEL 1: Discuss about data types and variables.

LEVEL 2: Demonstrate a simple java program

P3: Programming Exercises on operators, expressions based on a given scenario.

LEVEL 1: Explain operators, expressions.

LEVEL 2: Demonstrate operators

P4: Programming Exercises Command Line Arguments based on a given scenario.

LEVEL 1: Explain command line arguments

LEVEL 2: Demonstrate command line arguments

P5: Programming Exercises on basic Input/ Output functions and Control Statements: Branching

LEVEL 1: Explain Input/ Output functions

LEVEL 2:Demonstrate Control Statements: Branching

P6: Programming Exercises on Control Statements: Looping

LEVEL 1: Explain variour loops.

LEVEL 2:Demonstrate Control Statements: Looping

P7: Programming Exercises on Creating Objects, classes on a given scenario.

LEVEL 1: Illustrate class, object and methods.

LEVEL 2: Execute java program using class and objects

P8: Programming Exercises on Adding methods and Constructors to the class based on a given scenario.

LEVEL 1: Illustrate methods and constructors

LEVEL 2: Execute java program using methods and constructors

P9: Programming Exercises on methods based on a given scenario.

LEVEL 1: Illustrate method overloading

LEVEL 2: Apply method overloading for the given scenario.

P10: Programming Exercises on methods based on a given scenario.

LEVEL 1: Illustrate constructors overloading

LEVEL 2: Apply constructor overloading for the given scenario

P11: Programming Exercises on methods for static members bassed on a given scenario.

LEVEL 1: Benefits of usage static members

LEVEL 2: Usage of Static Members for the given scenario

P12: Programming Exercises on static methods based on a given scenario.

LEVEL 1: Benefits of usage static methods

LEVEL 2: Usage of Static Methods for the given scenario.

P13: Programming Exercises on nested Classes based on a given scenario.

LEVEL 1: Benefits of usage nested classes

LEVEL 2: Apply the concept of usage of nested classes for the given scenario

P14: Programming Exercises on Arrays and its built-in functions based on a given scenario.

LEVEL 1: Illustrate one dimensional arrays and its functions.

LEVEL 2: Demonstrate programs with single-dimensional arrays and operations.

P15: Programming Exercises on Arrays and its built-in functions based on a given scenario.

LEVEL 1: Illustrate multi dimensional arrays and its functions.

LEVEL 2: Demonstrate programs with multi-dimensional arrays and operations.

P16: Programming Exercises on String Class and its built-in functions based on a given scenario.

LEVEL 1: Explain about String class and String methods.

LEVEL 2: Execute simple java applications for String and StringBuffer operations

P17: Programming Exercises on String Buffer Class and its built-in functions based on a given scenario.

LEVEL 1: Explain about StringBuffer class and String methods.

LEVEL 2: Execute simple java applications for String and StringBuffer operations

P18: Programming Exercises on String Builders and its built-in functions based on a given scenario.

LEVEL 1: Explain about String Builders.

LEVEL 2: Execute java applications for String Builders

P19: Programming Exercises on single, multi level Inheritance and super keyword based on given scenario.

LEVEL 1: Explain single and multi level inheritance.

LEVEL 2: Demonstrate simple applications for the different types of inheritance

P20: Programming Exercises hierarchical Inheritance and super keyword based on given scenario.

LEVEL 1: Explain hierarchical inheritance.

LEVEL 2: Demonstrate simple applications for hierarchical inheritance

P21: Programming Exercises on Overriding.

LEVEL 1: Differentiate method overloading and method overriding.

LEVEL 2: Demonstrate simple program with dynamic method dispatch.

P22: Programming Exercises on Final based on given scenario.

LEVEL 1: Implement programs using concept of final.

LEVEL 2: Use final keyword for the given problem

P23: Programming Exercises on Abstract keyword based on given scenario.

LEVEL 1: Implement programs using concept of Abstract.

LEVEL 2: Use abstract keyword for the given problem

P24: Programming Exercises on Interface based on a given scenario.

LEVEL 1: Differentiate abstract class about interface

LEVEL 2: Implement interfaces in the given problem

P25: Programming Exercises on Exception Handling based on a given scenario.

LEVEL 1: Explain exception handling

LEVEL 2: Solve the given problem using exception handling mechanism.

P26: Programming Exercises on Character Stream Classes based on a given scenario.

LEVEL 1: Explain Character Stream Classes

LEVEL 2: Solve the given problem using Character Stream Class.

P27: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P28: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P29: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

P30: Programming Exercises on Read/Write Operations with File Channel based on a given scenario.

LEVEL 1: Explain Read/Write Operations with File Channel

LEVEL 2: Solve the given problem using Read/Write Operations with File Channel.

Targeted Application & Tools that can be used : JDK /eclipse IDE/ net Beans IDE.

Text Book

T1 Herbert Schildt, "The Complete Reference Java 2", Tata McGraw Hill Education, 11th Edition,2019.

References

R1. Cay S Horstmann and Cary Gornell, "CORE JAVA volume I-Fundamentals", Tenth Edition, Pearson 2015.

R2: James W. Cooper, "Java TM Design Patterns – A Tutorial", Addison-Wesley Publishers.4th Edition, 2000.

R3. E. Balagurusamy, "Programming with Java", Tata McGraw Hill Education, 6th Edition, 2019.

E book link R1: http://rmi.yaht.net/bookz/core.java/9780134177373-Vol-1.pdf

E book link R2: Java(tm) Design Patterns: A Tutorial([PDF] [7qmsenjl97t0] (vdoc.pub)

Web **resources**

ps://youtube.com/playlist?list=PLu0W_9lII9agS67Uits0UnJyrYiXhDS6q

ps://puniversity.informaticsglobal.com:2229/login.aspx

Topics relevant to development of "Skill Development":

1. Static Polymorphism
2. Method overloading, constructors
3. constructor overloading
4. this keyword
5. static keyword and Inner classes
6. Inheritance and Polymorphism.

for **Skill Development** through **Experiential Learning** techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr Robin
Recommended by the Board of Studies on	BOS Meeting NO: 12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 16th, Dated 23/10/2021

Couse Code ENG2001	Course Name Advanced English	L- T- P- C	1	0	2	2
Version No.	2.0					
Course Pre-requisites						
Anti-requisites	**NIL**					
Course Description	This course is designed to equip students to enhance their communication abilities in Listening, Speaking, Reading, and Writing. The curriculum covers interpersonal communication principles, the art of speech writing and delivery (including impromptu speaking), strategic approaches to critical reading, the identification of logical fallacies, and persuasive writing. Furthermore, the course will introduce students to the potential of AI tools and the techniques of prompt engineering to elevate their communication skills in the digital age. Upon course completion, students will be well-prepared to communicate effectively and critically in both academic and professional environments.					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Recognize the elements of interpersonal and cross-cultural communication to address communication challenges effectively. 2. Demonstrate the ability to deliver structured and impromptu speeches using effective speaking techniques. 3. Interpret textual and visual materials using critical reading strategies to evaluate arguments, logic, and persuasion. 4. Produce persuasive and analytical essays using effective argumentation techniques and structured writing strategies.					

Course Content: Theory

Module 1	**Foundations of Effective Communication**	**Case Studies/ Role play**	**Cross-Cultural Competency**	**4 Classes**

Topics:
- Fundamentals of Interpersonal Communication
- Verbal, Non-verbal, and Paraverbal communication.
- Cultural dimensions theory (Hofstede's Cultural Dimensions).
- Active Listening Techniques
- Common Errors in Communication

Module 2	**Mastering Speech Delivery**	**JAM**	**Public Speaking Confidence**	**4 Classes**

Topics:
- Introduction to Prompt Engineering
- Speech Preparation and Organization
- Techniques for Effective Impromptu Speaking
- Practice Speech Delivery

Module 3	**Critical Reading and Logical Analysis**	**Worksheet**	**Critical Thinking and Analysis**	**4 Classes**

Topics:
- Critical Reading Strategies: Contextualizing, Figurative Language, Evaluating Logic of an Argument, Recognizing Emotional Manipulation, Analysing Visuals

- Recognizing Logical Fallacies: Slippery Slope, False Dilemma, Post Hoc, Hasty Generalization, Ad Hominem, Straw Man, Bandwagon, No True Scotsman, Red Herring, Appeal to Authority, Sunk Cost, Appeal to ignorance

Module 4	**Writing Effective Arguments**	**Assignment**	**Clear and Coherent Writing**	**3 Classes**

Topics**:**

- Understanding Critical Writing
- Building Arguments (Pathos, Ethos, Logos)
- Techniques for Persuasion

Course Content: Practical Sessions

Module 1	**Foundations of Effective Communication**	**8 Classes**

1. **Interpersonal Communication**
   Charades with a Twist/Tone and Emotion Experiment/Mixed Messages Challenge/Role Reversal Conversations/Observation Exercise
2. **Cross-cultural Communication**
   Cultural Iceberg Analysis/Role-Play: Cross- Cultural Scenarios/Stereotypes vs Realities/Cross- /Cultural Negotiation Exercise/Cultural Sensitivity Case Studies
3. **Active Listening**
   Bingo TEDx/Story Building/Listening for Key Details/Interactive Podcast Listening/Fact or Opinion
4. **Instagram/YouTube Vocabulary Activity**

Module 2	**Mastering Speech Delivery**	**8 Classes**

5. **Speech Writing**
6. **Impromptu Speech**
   JAM /"Would You Rather" Explainer/Picture Prompt Speech/Reverse Speech Crafting

Module 3	**Critical Reading and Logical Analysis**	**8 Classes**

7. **Critical Reading Strategies**
   Critical Reading Worksheet/Identifying Bias in News Articles
8. **Recognizing Logical Fallacies**
   Debate Challenge with Fallacy Detection/ Fallacy Investigation with Podcasts or Social Media

Module 4	**Writing Effective Arguments**	**6 Classes**

9. **Building Arguments**
   Causes or Effects/Appeal Mash-Up/Debates on Controversial Topics
10. **Persuasive Writing**
    Creative Persuasive Writing/Opinion Writing

Targeted Application & Tools that can be used: Quizziz, Chatgpt, Gemini, Youtube, Instagram, Quillbot, Grammarly, Padlet

References

1. Adler, R. B., Rodman, G., & DuPré, A. (2019). *Understanding human communication (14th ed.)*. Oxford University Press.
2. Moore, B. N., & Parker, R. (2020). *Critical thinking* (13th ed.). McGraw-Hill Education.

<table>
<tr><td colspan="2">3. DeVito, J. A. (2019). The interpersonal communication book (15th ed.). Pearson.
4. Ting-Toomey, S., & Dorjee, T. (2018). Intercultural competence: A model for teaching and assessing cross-cultural communication. Journal of Intercultural Communication, 47(2), 213–229. https://doi.org/10.1016/j.jicc.2018.03.004
5. https://www.ted.com/</td></tr>
<tr><td colspan="2">Topics Relevant to “employability”: Teamwork and Collaboration, Critical Thinking and Problem-Solving
Topics Relevant to “Human Values and Professional Ethics”: Critical reasoning, Inclusivity and Fairness</td></tr>
<tr><td>Catalogue prepared by</td><td>Dr. Tychicus David, Dr. Jayalakshmi E</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 12th BOS held on 10/08/2021</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 16th, Dated 23/10/2021</td></tr>
</table>

<table>
<tr><td>Course Code:
MAT1003</td><td colspan="2">Course Title: Applied Statistics
Type of Course: School Core</td><td>L –T- P C</td><td>1</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Version No.</td><td colspan="7">3.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">None</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">None</td></tr>
<tr><td>Course Description</td><td colspan="7">The goal of this course is to provide a firm understanding of probability and statistics by means of a thorough treatment of descriptive statistics, probability and probability distributions keeping in mind the future courses having statistical, quantitative and probabilistic components. The course covers topics such as descriptive statistics, probability, rules for probability, random variables and probability distributions, standard discrete and continuous probability distributions.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of "Applied Statistics" and attain Skill Development Through Problem Solving techniques.</td></tr>
<tr><td>Expected Outcome:</td><td colspan="7">At the end of this course, students will be in a position to
1. apply the techniques of descriptive statistics effectively
2. interpret the ideas of probability and conditional probability
3. demonstrate the knowledge of probability distributions
4. Compute statistical parameters, correlation and regression, probability and sampling distributions using R software.</td></tr>
<tr><td>Module 1</td><td colspan="2">Descriptive Statistics</td><td>Assignment</td><td colspan="2">Coding needed</td><td colspan="2">10 classes</td></tr>
<tr><td colspan="8">Introduction to Statistics, Data and statistical thinking, review of basic statistical parameters, Covariance, Correlation, Types of Measures of Correlation - Karl Pearson's Correlation Coefficient, Spearman Rank Correlation, linear regression, Multi linear regression.</td></tr>
<tr><td>Module 2</td><td colspan="2">Probability</td><td></td><td colspan="2"></td><td colspan="2">6 classes</td></tr>
<tr><td colspan="8">Introduction to Probability, Probability of an event, Addition Principle, Multiplication law, Conditional Probability, Total Probability and Baye's theorem with examples</td></tr>
<tr><td>Module 3</td><td colspan="2">Random Variables and Probability Distributions</td><td></td><td colspan="2">Coding needed</td><td colspan="2">14 classes</td></tr>
<tr><td colspan="8">Introduction to Random variables, Discrete Random Variables and Continuous Random Variables, Probability Distributions, Probability Mass Function and Probability Density Function, Various Probability distributions, Binomial, Negative Binominal (Self Study), Poisson, Normal and Exponential distributions</td></tr>
<tr><td>Module 4</td><td colspan="2">Sampling Theory</td><td></td><td colspan="2">Coding needed</td><td colspan="2">15 classes</td></tr>
<tr><td colspan="8">Introduction to Sampling Theory, Population, Statistic, Parameter, Sampling Distribution, Standard Error. Testing of Hypothesis, Types of Errors, Critical Region, level of Significance. Difference between Parametric and Non-parametric Tests, Large Sample Tests: Z-Test for Single Mean and Difference of Means (Self Study), Small Sample Tests: Student's t-Test for Single Mean and Difference of Means, F-Test, Chi-Square Test.</td></tr>
<tr><td colspan="8">Targeted Application & Tools that can be used:
The objective of the course is to familiarize students with the theoretical concepts of probability and statistics and to equip them with basic statistical tools to tackle engineering and real-life problems.
Tools used: R Software / MS-Excel</td></tr>
<tr><td colspan="8">Text Book
1. Ronald E Walpole, Raymond H Myers, Sharon L Myers, and Keying E Ye, Probability and Statistics for Engineers and Scientists, Pearson Education, 2016.</td></tr>
<tr><td colspan="8">References</td></tr>
</table>

<table>
<tr><td colspan="2">1. James T. McClave, P. George Benson and Terry Sincich, Statistics for Business and Economics, 2018.
2. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Essentials of Modern Business Statistics with Microsoft Excel, 2020.
3. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Essentials of Statistics for Business and Economics, 2019.
4. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons, 2018.
5. Richard A. Johnson, Miller and Freund’s Probability and Statistics for Engineers, 2018.
6. Kishor S Trivedi, Probability and Statistics with reliability, Queuing and Computer Science Applications, John Wiley & Sons, 2008</td></tr>
<tr><td colspan="2">Topics relevant to SKILL DEVELOPMENT: The goal of this course is to provide a firm understanding of probability and statistics by means of a thorough treatment of descriptive statistics, probability and probability distributions keeping in mind the future courses having statistical, quantitative and probabilistic components. The course covers topics such as descriptive statistics, probability, rules for probability, random variables and probability distributions, standard discrete and continuous probability distributions for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.</td></tr>
<tr><td>Catalogue prepared by</td><td>Dr. Sathish S and Dr. Juliet Raja</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>13th BOS held on 04/01/2025</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>24th ACM held in 3rd August 2024</td></tr>
</table>

Course Code: MAT1002	**Course Title: Transform Techniques, Partial Differential Equations and Their Applications** **Type of Course: School Core**	**L-T-P- C**	**3**	**0**	**0**	**3**
Version No.	2.0					
Course Pre-requisites	**MAT1001 - Linear Algebra and Calculus**					
Anti-requisites	**NIL**					
Course Description	This course aims to introduce various transform techniques such as Laplace transform, Fourier transform and Z transform in addition to expressing functions in terms of Fourier series. The course covers applications of Laplace transform to LCR circuits and solution of difference equations using z-transform. The course also deals with the analytical methods for solving partial differential equations and the classical applications of partial differential equations.					
Course Objective	The objective of the course is **Skill Development** of student by using **Problem Solving Techniques.**					
Course Outcomes	On successful completion of this course the students shall be able to: CO-1: Express functions in terms of uniformly convergent Fourier series. CO-2: Apply Laplace transform technique to solve differential equations. CO-3: Employ z-transform technique to solve difference equations. CO-4: Solve a variety of partial differential equations analytically.					
Course Content:						
Module 1	**Fourier Series**					**10 CLASSES**
Fourier series: Fourier series - Euler's formulae - Dirichlet's conditions - Change of Interval - half range series – RMS value – Parseval's identity – Computation of harmonics. Engineering Applications of Fourier series.						
Module 2	**Integral Transforms**					**15 Classes**
Laplace Transform: Definition and Laplace transforms of elementary functions. Properties of Laplace transform. Laplace transform of periodic function, unit-step function and impulse function and the related problems. Inverse Laplace transform of standard functions and problems, initial and final value theorems. Convolution theorem, solution of linear ordinary differential equations, LCR circuit problems. **Fourier Transform:** Integral transforms, infinite Fourier transforms, Fourier sine and cosine transforms, inverse Fourier transforms. Engineering Applications of Fourier transform.						
Module 3	**Z Transform and Difference Equations**					**8 Classes**
Definition of Z-transform, Z transforms of standard functions and the related problems, standard inverse Z transforms and problems, computation of inverse Z-transform by partial fraction and convolution methods, solution of difference equations using Z-transforms. Business and Engineering Applications of Z transform.						
Module 4	**Partial Differential Equations**					**12 Classes**
Partial Differential Equations: Formation of PDEs, solution of non-homogeneous PDEs by						

direct integration, solution of homogeneous PDEs involving derivatives with respect to only one independent variable, method of separation of variables, solution of the Lagrange's PDE of the type Pp + Qq = R.

Applications of PDEs: Various possible solutions of the one dimensional wave and heat equations by the method of separation of variables, D'Alembert's solution of the wave equation, solution of related boundary value problems.

Targeted Applications & Tools that can be used:

Applications to electrical engineering, vibrational analysis, acoustics, optics, signal processing, image processing, quantum mechanics, econometrics and shell theory by means of Fourier Series and integral transforms.

Opens up new approaches in terms of Z-transform to solving one of the central problems of modern science involving difference equations.

Finding the solutions of boundary value problems involving PDEs with reference to wave, heat, and Laplace equations.

Assignment: Mention the Type of Project /Assignment proposed for this course

Two Assignments based on the applications of the concepts leading to a minimum of 5 engineering problems from a common pool of problems.

Text Book

1. Erwin Kreyszig, 2017: " Advanced Engineering Mathematics", 10th Edition, John Wiley.

References:

6. B. S. Grewal, 2017: "Higher Engineering Mathematics" 45th Edition, Khanna Publishers.
7. Peter V O'Neil, 2015: "Advanced Engineering Mathematics", 7th Edition, Cengage Learning.
8. Glyn James, 2016: "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education.
9. Michael D. Greenberg, 2018: "Advanced Engineering Mathematics", 2nd Edition, Pearson Education.

Topics relevant to the development of Foundation Skills: **All the solution methods.**

Topics relevant to development of Employability skills: **Use of relevant scientific application packages.**

Catalogue prepared by	Dr.Veeresha A Sajjanara and Dr.Ananya Tripathi
Recommended by the Board of Studies on	12th BOS held on 05/07/2024
Date of Approval by the Academic Council	24th ACM held in 3rd August 2024

Course Code: PPS 1002	**Course Title: Soft skills for Engineers** Type of Course: **Practical Only Course**	L- P- C	0	2	1
Version No.	1.0				
Course Pre-requisites	Students are expected to understand Basic English. Students should have desire and enthusiasm to involve, participate and learn.				
Anti-requisites	NIL				
Course Description	This course is designed to develop effective communication skills and boost confidence levels. The activity-based modules cover the art of Questioning, how to ask questions, goal setting with emphasis on time and stress management, creating the first impression and introducing one self and finally culminating with the etiquettes of email writing. The pedagogy used will be group discussions, flipped classrooms, continuous feedback, role-play and mentoring.				
Course Objective	The objective of the course is to **familiarize the learners with the concepts of "Soft Skills for Engineers" and attain Skill Development** through **Experiential Learning techniques**.				
Course Out Comes	**On successful completion of this course the students shall be able to:** CO1 **Employ** effective communication skills CO2 **Practice** questioning techniques for better decision making CO3 **Differentiate** individual strengths and weaknesses for self-awareness and stress management CO4 **Recognise** the need to set SMART GOALS				
Course Content:					
Module 1	Art of Questioning	Role plays	4 classes		
Topics: Note Taking, Framing Open-ended and Close-ended questions, Funnel technique, Probing questions, Leading questions, Rhetorical questions, 5W1H Technique					
	Vocab Building		Every Class		
Dedicate 5-10minutes towards vocabulary building in every session					
Module 2	Goal Setting & Time Management	Journal + Outbound training	8 Classes		
Goal Setting (SMART Goals), Time Management Matrix, Steps to managing time through outbound group activity, Making a schedule, Daily Plan and calendars (To Do List), Monitoring/charting daily activity					
Module 3	Self-introduction and Creating an Impression	Grooming checks + Evaluation	8 classes		
Topics: Body Language, Grooming guidelines for boys/girls, Common mistakes in Grooming at workplace and social gathering, Etiquettes at work place & social gathering, SWOT – Self-awareness analysis, Self-introduction template, evaluation of self-introduction in class					
Module 4	E-mail Etiquette	Industry expert / Trainer	4 Classes		

Topics: Dos and Don’ts of professional email etiquette, practice writing emails (activity)			
REVISION	Recap & Summary		2 Classes
Revision of all the modules, overall feedback from the students with regards to the syllabus.			
Targeted Application & Tools that can be used: LMS			
Topics relevant to development of “SKILL”: Art of Questioning, Goal Setting & Time Management, Self-introduction and Creating an Impression, E-mail Etiquette for Skill Development through Participative Learning Techniques. This is attained through assessment component mentioned in course handout. (Self-Introduction, Goal Setting, LMS Quiz)			

Catalogue prepared by	L&D Department Faculty members
Recommended by the Board of Studies on	BOS NO 3 Dated 10 Feb 23
Date of Approval by the Academic Council	20 ACM dated 15 Feb 23

Coursen Code: PPS2001	Course Title: Reasoning and Employment Skills Type of Course: Practical	L-P-C	0	2	1
Version No.	1.1				
Course Pre-requisites	Students are expected to understand Basic English. Students should have desire and enthusiasm to involve, participate and learn.				
Anti-requisites	**NIL**				
Course Description	The objective of this course is to introduce Engineering students to the importance of reasoning and develop their ability to identify problems, assess and arrive at an informed decision in various situations. The course will benefit learners in quick thinking and adapting and working in a team, handle conflict and think critically. This course is both conceptual and experiential in nature that would help the student to communicate effectively. After successful completion of the Course, the students would be able to participate in team activities effectively, reason and think critically, organize thoughts and express themselves confidently.				
Course Objective	The objective of the course is skill development of students by using Participative and Experiential Learning techniques.				
Course Out Comes	On successful completion of the course the students shall be able to: 1] **Demonstrate** quick thinking skills 2] **Recognize** the skills required to work in a team 3]**Define** Conflict Resolution 4] **Select** strategy to resolve conflict 5] **Analyze** information in a critical manner				
Course Content:					
Module 1	Activity Based Learning – Let's Team Up			**4 Sessions**	
Topics: Significance of a Team, Characteristics of a Team, Stages of Team formation, Skills of an effective team player					
Module 2	Let's Patch Up Conflict Resolution			**6 Sessions**	
Topics: What is conflict, what is conflict resolution, importance of conflict resolution, causes of conflict, techniques to resolve conflicts					
Module 3	Think on your Toes Just A Minute (JAM)	Assessment	One minute talk	**12 Sessions**	
Topics: Communication Building – Opening Body Closing Mind-Mapping, Data, Example Facts, Analysis, Ideas, Opinions, Quotes, Questions Technique (DEFAIOQ) **Assignment:** Speak for a minute on a given topic					

Module 4	Think Tank Critical Thinking			**4 Sessions**

Topics:
5 skills of Critical Thinking- observation, analysis, inference, communication, problem solving

Targeted Application & Tools that can be used:
LMS

Project work/Assignment:

To be able to organize thoughts, express themselves and speak confidently in front of an audience
Assignment: 1. Just a Minute
2. LMS

References

R1. The 17 Indisputable Laws of TeamWork John Maxwell Harper Collins 2013.

R2. The 17 Qualities of a Team Player John Maxwell 2006

R3. Talking to Strangers by Malcolm Gladwell Little - John MaxwellBrown and Company 2019.

R4. The 7 Effective Communication Skills – How to be a Better Communicator Now – Gabriel Angelo CreateSpace Independent Publisher 2014

R5. Prakash Iyer, *"The Habit of Winning"*, 2nd Edition, Penguin Books Ltd., 2016
R6. Jack Canfield, *"The Success Principles"*, 8th Edition, HarperCollins Publishers India, 2015
R7 Critical Thinking Skills Developing Effective Analysis and Argument - Stella Cottrell

/eb links:
https://ideas.ted.com/critical-thinking-is-a-21st-century-essential-heres-how-to-help-kids-learn-it
https://www.youtube.com/watch?v=Dp5vqxEot1c
https://www.youtube.com/watch?v=B24niubF5hA
https://presiuniv.knimbus.com/user#/home

Topics relevant to development of "SKILL": Art of Questioning, Goal Setting & Time Management, Self-introduction and Creating an Impression, E-mail Etiquette for Skill Development through Participative Learning Techniques. This is attained through assessment component mentioned in course handout. (Self-Introduction, Goal Setting, LMS Quiz)

Catalogue prepared by	L&D Department Faculty members
Recommended by the Board of Studies on	BOS NO 3 Dated 10 Feb 23
Date of Approval by the Academic Council	20 ACM dated 15 Feb 23

Course Code: **ECE1006**	**Course Title: Basic Electronics Engineering** **Type of Course: School Core (Theory & Integrated Laboratory)**	**L- T-P-C**	3	0	2	4
Version No.	1.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**Nil**					
Course Description	**The purpose of this course is to enable the students to learn the fundamental concepts of electronic devices and circuits. The course aims at nurturing the students with the fundamental principles of electronics engineering, prevailing in various engineering applications. The nature of the course is conceptual and analytical which imparts knowledge of electronic components and their behavior under various operating conditions. The course develops thinking skills of the students, encouraging their quest for knowledge about electronic devices and their usage in higher semester courses.** **The associated laboratory provides an opportunity to validate the concepts taught in theory classes and enable the students to work with basic electronic circuits using electronics components.**					
Course Objectives	**The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) Identify various electrical and electronic components and basic electrical laws. 2) Explain applications of Diodes and BJTs. 3) Summarize the concepts of Digital Electronics and Communication Systems. 4) Discuss the basic concepts of microprocessor and computer organization. 5) Perform experiments to familiarize various Electrical & Electronic components and equipment. 6) Verify Basic Electrical Circuit configurations and Laws.					
Course Content:						
Module 1	**Module-1: Basic Electrical and Electronic Components**	Assignment / Quiz	Identification of Practical electronic and electrical components / Memory Recall based Quizzes	**10 Sessions**		

Topics:
ELECTRICAL CIRCUITS AND LAWS: DC Circuits: Classification of Electrical Elements, Ohm's law, Series and Parallel Circuits, Kirchhoff's Voltage and Current laws, Power and Energy, Transformers and their types.
ELECTRONIC MATERIALS AND COMPONENTS: Conductors, Insulators, Semi-Conductor Material, P-N Junction diode, Characteristics and Parameters, Ideal Diode approximations, DC load line.

Module 2	**Applications of Diodes and Introduction to BJT**	Assignment / Quiz	Simulation Task / Memory Recall based Quizzes	**12 Sessions**

Topics:
RECTIFIERS: Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Capacitor filter circuit (only qualitative approach).
ZENER DIODE: Zener diode, Zener Characteristics, Zener diode as a voltage regulator.
BIPOLAR JUNCTION TRANSISTORS: BJT Construction and Operation, BJT Voltages and Currents, Common Base, Common Emitter Configuration and Characteristics, Current amplification Factor alpha and beta, DC Load line w.r.t. fixed bias circuit (Q-Point), AC Analysis.

Module 3	**Digital Electronics and Communication System**	Assignment / Quiz	Simulation Task / Memory Recall based Quizzes	**13 Sessions**

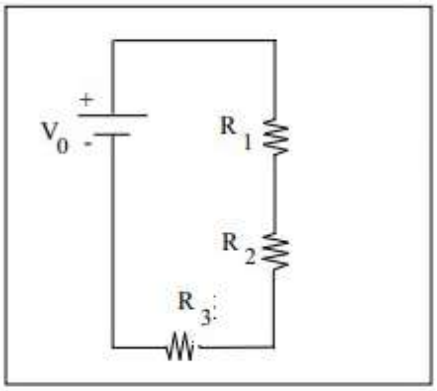
Topics:
NUMBER SYSTEMS: Decimal Number System, Binary Number System, Hexadecimal Number System, Conversions: Binary to and from Hexadecimal; Hexadecimal to and from Decimal; 1's and 2's Complement of Binary Numbers, Binary Addition.
BOOLEAN ALGEBRA: Boolean Laws and Theorems, De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, X-NOR Gate, NAND Gate, NOR Gate.
COMMUNICATION SYSTEM: Block diagram of communication system, Modulation: Definition of Modulation, Need of Modulation, Types of Modulation: Amplitude Modulation and Frequency Modulation (Waveforms only).

Module 4	**Microprocessors and Computer Organization**	Assignment / Quiz	Memory recall based Quizzes	**10 Sessions**

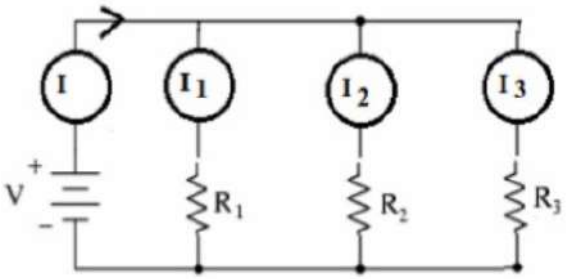
Topics:
INTEL 8085 MICROPROCESSOR: Basic Architecture and features of 8085 Microprocessor.
COMPUTER ORGANISATION: Basic structure of Computer Organisation describing the various Computer types, Functional Units, Basic Operational concepts, Bus Structures, Memory System: RAM and ROM.

List of Laboratory Tasks:
Experiment No. 1: Study of Resistors, Measuring instruments and DC Power Supply.
Level 1: Identification of resistor values from color bands and verification with Multimeter.
Level 2: Connecting a resistive circuit to a DC Power Supply and observing the input and output values using Voltmeters, Ammeters and hence calculate resistance values.
Experiment No. 2: Study of Reactive components, Multimeter, CRO and Function Generator.
Level 1: Identification of various types of capacitive and inductive components and verification with Multimeter.
Level 2: Connecting a reactive circuit to a function generator and observing the input and output waveform on CRO and calculation of Reactance and Impedance.
Experiment No. 3: Study of Ohm's Law.
Level 1: Rig up the circuit and verify Ohm's Law.
Level 2: Connect a 100Ω Resistor to a Voltage source of 0-5V. Plot a V- I graph by tabulating the Voltage Vs Current Values accordingly. Repeat the experiment for 1KΩ resistor and compare the results.

Experiment No. 4: Study of Series and Parallel Resistor Connections.
Level 1: Carry out the equivalent resistance of given four resistors 100Ω each connected in series and parallel combination using breadboard.
Level 2: Rig up a Current Divider Circuit and a Voltage Divider Circuit and verify the results.
Experiment No. 5: Study of Kirchhoff's Voltage Law and Kirchhoff's Current Law.
Level 1: Verify KVL and KCL with circuit (a) and circuit (b) with #values.

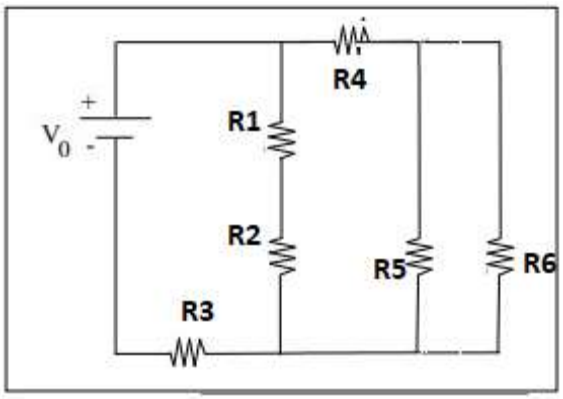


(a)



(b)

Level 2: Verify KCL with the help of given circuit having # values and carry out the equivalent resistance of the circuit by experimental and analytical methods.



Experiment No. 6: Study of PN-Junction Diode Characteristics in Forward and Reverse Bias Conditions.
Level 1: Carry out the experiment to find cut-in voltage on forward characteristics for Silicon P-N Junction diode.
Level 2: Carry out experiment to plot VI Characteristics of Silicon P-N Junction Diode in both forward and reverse biased conditions for Si P-N Junction diode.

Experiment No. 7: Study of Bipolar Junction Transistor in different regions of operation.
Level 1: Carry out the experiment to understand the importance of active, cut off and saturation regions.
Level 2: Carry out the experiment to design and analyze the operation of transistor as switch.

Experiment No. 8: Study of basic Digital Logic Gates using Integrated Chips IC's: NOT, AND, OR, XOR, NAND and NOR Gates
Level 1: Carry out the experiment to study and verify the truth table of logic gates using Digital ICs.
Level 2: Implementation of operation of a basic Boolean expression using basic gates.

Experiment No. 9: Study of Computer Organization: Identification of Components on Motherboard: CPU: Processor Chips (Processor Socket), PCI, Parallel Ports, Universal Serial

Bus: USB, I/O Connectors, RAM Slots.
Level 1: Carry out the experiment to familiarize a computer system layout and mark the positions of SMPS, Motherboard, FDD, HDD, CD / DVD drive and add on cards.
Level 2: Study of a Desktop PC and its assembling.

Targeted Application & Tools that can be used:

Student will be able to find career opportunities in various domains such as Analog Electronics, Digital Electronics, Microprocessors, VLSI Design, Telecommunication, Computers and Wireless Communication. The students will be able to join a profession which involves basics to high level of electronic circuit design.
Professionally Used Software: MultiSim / PSpice
Besides these software tools hardware equipment such as Multimeters, Function Generators, Power Supplies, Oscilloscopes etc., can be used to perform component/circuit testing and analysis.

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project/Programming Assignment: Students will be made into group and given the programming assignment at the end of each module. Students need to use MULTISIM for this assignments.
Sample Assignment 1: **AC to DC power conversion using rectifier circuits both HWR and FWR.**
Sample **Assignment 2: Plot the V-I Characteristics of Zener Diode and illustrate the use of Zener diode to maintain a Constant Voltage Level.**
Sample **Assignment 3: Implementation of Boolean Expression using AND-OR and NAND-NAND Logic.**

5. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.
Presidency University Library Link .

Textbook(s):

T1. John Hiley, Keith Brown and Ian McKenzie Smith, *"Hughes Electrical and Electronic Technology",* Pearson,12th Edition
T2. William Stallings, "Computer Organization and Architecture Designing for Performance", Pearson Education, 10th Edition.

Reference(s):
Reference Book(s):

R1. Smarajit Ghosh, *"Fundamentals of Electrical and Electronics Engineering"*, PHI, 2nd Edition
R2. D.P. Kothari, I. J. Nagrath, *"Basic Electronics",* McGraw Hill Education, 1st Edition
R3. Rajendra Prasad, *"Fundamentals of Electronics Engineering",* Cengane Learning, 3rd

Edition

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on "BASIC ELECTRONICS" by Prof. Dr. Chitralekha Mahanta, Department of Electronics and communication Engineering, IIT Guwahati": https://nptel.ac.in/courses/117/103/117103063/
2. Lecture Series on " Useful Laws in Basic Electronics" by Prof. T.S.Natarajan, Department of physics, IIT Madras: https://www.youtube.com/watch?v=vfVVF58FtCc
3. Lecture Series on "Introduction to Bipolar Junction Transistors BJT " by All About Electronics Youtube Channel: https://www.youtube.com/watch?v=-VwPSDQmdjM&list=PLwjK_iyK4LLDoFG8FeiKAr3IStRkPSxqq
4. Lecture Series on " PN Junction Diode " by All About Electronics Youtube Channel: https://www.youtube.com/watch?v=USrY0JspDEg
5. Lecture Series on "Introduction to Digital Electronics" by All About Electronics Youtube Channel: https://www.youtube.com/watch?v=DBTna2ydmC0&list=PLwjK_iyK4LLBC_so3odA64E2MLgIRKafl
6. Lecture Series on "Introduction to Microprocessors" by Bharat Acharya Education : https://www.youtube.com/watch?v=0M74z5jEAyA
7. Lecture Notes on : "Electronic Devices", Bipolar Junction Transistors, 2nd Chapter, by Shree Krishna Khadka (PDF) Bipolar Junction Transistor (researchgate.net) https://www.researchgate.net/publication/323384291_Bipolar_Junction_Transistor

E-content:

1. V. Milovanovic, R. van der Toorn, P. Humphries, D. P. Vidal and A. Vafanejad, "Compact model of Zener tunneling current in bipolar transistors featuring a smooth transition to zero forward bias current," *2009 IEEE Bipolar/BiCMOS Circuits and Technology Meeting*, 2009, pp. 99-102, doi: 10.1109/BIPOL.2009.5314134. https://ieeexplore.ieee.org/document/5314134
2. M. Oueslati, H. Garrab, A. Jedidi and K. Besbes, "The advantage of silicon carbide material in designing of power bipolar junction transistors," 2015 IEEE 12th International Multi-Conference on Systems, Signals & Devices (SSD15), 2015, pp. 1-6. https://ieeexplore.ieee.org/document/7348149
3. H. Luo, F. Iannuzzo, F. Blaabjerg, X. Wang, W. Li and X. He, "Elimination of bus voltage impact on temperature sensitive electrical parameter during turn-on transition for junction temperature estimation of high-power IGBT modules," *2017 IEEE Energy Conversion Congress and Exposition (ECCE)*, 2017, pp. 5892-5898 https://ieeexplore.ieee.org/document/8096974
4. F. Bauer, I. Nistor, A. Mihaila, M. Antoniou and F. Udrea, "Super junction IGBT Filling the Gap Between SJ MOSFET and Ultrafast IGBT," in *IEEE Electron Device Letters*, vol. 33, no. 9, pp. 1288-1290, Sept. 2012 https://ieeexplore.ieee.org/document/6246672
5. https://presiuniv.knimbus.com/user#/home

Topics related to development of "FOUNDATION SKILLS": Electrical & Electronic component and laws, Fundamentals of Digital Electronics, Communication Systems, Microprocessors and Computer Organization.

Catalogue prepared by	Dr. Safinaz S Mrs. Anusha R Mr. Arvind Kumar
Recommended by the Board of	BOS Meeting NO: 19th BOS held on 06/07/2024

Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE2010</td><td colspan="3">Course Title: Innovative Projects using Arduino</td><td>L- T-P- C</td><td>-</td><td>-</td><td>-</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">This course is designed to provide an in-depth understanding of Arduino microcontrollers and their application in various real time projects involving sensors. Throughout the course, students will learn the fundamentals of Arduino programming and gain hands-on experience with a wide range of sensors. Students will explore how to connect and interface sensors with Arduino boards, read sensor data, and use it to control various output devices This course is suitable for beginners who are interested in exploring the world of electronics and developing practical applications using Arduino and sensors.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is Employability Skills of student by using PARTICIPATIVE LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of the course the students shall be able to
1) Explain the main features of the Arduino prototype board
2) Demonstrate the hardware interfacing of the peripherals to Arduino system.
3) Understand the types of sensors and its functions
4) Demonstrate the functioning of live projects carried out using Arduino system.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Basic concepts of Arduino</td><td>Hands-on</td><td colspan="3">Interfacing Task and Analysis</td><td>4 Sessions</td></tr>
<tr><td colspan="9">Topics:
Introduction to Arduino, Pin configuration and architecture, Device and platform features, Concept of digital and analog ports, Familiarizing with Arduino Interfacing Board, API’s , Introduction to Embedded C and Arduino platform, Arduino Datatypes and variables, Arduino i/o Functions, Arduino Communications, Arduino IDE, Various Cloud Platforms.</td></tr>
<tr><td>Module 2</td><td colspan="2">Sensory Devices</td><td>Hands-on</td><td colspan="3">Interfacing Task and Analysis</td><td>4 Sessions</td></tr>
<tr><td colspan="9">Arduino Sensors: Humidity Sensor, Temperature Sensor, Water Detector / Sensor, PIR Sensor, Ultrasonic Sensor, Connecting Switches and actuators, sensor interface with Arduino.
Introduction to 3D Printer: 3D Printer technology and its working Principles, Applications.
Introduction to online Simulators: Working with Tinkercad Simulator.</td></tr>
<tr><td colspan="9">Topics: Types of Arduino boards, sensors, 3D Printer</td></tr>
<tr><td colspan="9">Targeted Application & Tools that can be used:</td></tr>
</table>

Application Area:
Home Automation, Environmental Monitoring, Agriculture and Farming, Industrial Automation, Internet of Things (IoT), Robotics, Wearable Devices, Security Systems, Education and Learning. These are just a few examples of the many application areas where Arduino and sensors can be applied. The flexibility and affordability of Arduino, combined with the wide range of sensors available, allow for endless possibilities in creating innovative projects.
Professionally Used Software: students can use open SOURCE Softwares Arduino IDE and Tincker CAD

Project work/Assignment:

1. Projects: At the end of the course students will be completing the project work on solving many real time issues.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a presentation from interdisciplinary students group, where the students will be given a project on they have to demonstrate the working and discuss the applications for the same

Textbook(s):
Monk Simon "Programming Arduino: Getting Started with Sketches", Mc Graw Hill Publications Second Edition

References
Reference Book(s)
1. Neerparaj Rai "Arduino Projects for Engineers" BPB publishers,first edition, 2016.
2. Ryan Turner "Arduino Programming " Nelly B.L. International Consulting Ltd, first edition,2019.

Online Resources (e-books, notes, ppts, video lectures etc.):
1. Arduino trending Projects < https://www. https://projecthub.arduino.cc/>
2. Introduction to Arduino < https://onlinecourses.swayam2.ac.in/aic20_sp04/preview>
3. Case studies on Wearable technology< https://www.hticiitm.org/wearables>

E-content:
1. Cattle Health Monitoring System Using Arduino and IOT (April 2021| IJIRT | Volume 7 Issue 11 | ISSN: 2349-6002)

2. M H Hemanth Kumar, Ravi Pratap Singh, Nishu Sharma, Pragya Singh" IOT BASED SMART SECURITY SYSTEM USING ARDUINO" 2021 JETIR August 2021, Volume 8, Issue 8.

3. R. Maheswar, P. Jayarajan, S. Vimalraj, G. Sivagnanam, V. Sivasankaran and I. S. Amiri, "Energy Efficient Real Time Environmental Monitoring System Using Buffer Management Protocol," 2018, pp. 1-5, doi: 10.1109/ICCCNT.2018.8494144. https://ieeexplore.ieee.org/document/8494144.
4. Yaser S Shaheen,Hussam., " Arduino Mega Based Smart Traffic Control System ," December 2021 Asian Journal of Advanced Research and Reports 15(12): 43-52, 2021(15(12): 43-52, 2021):15(12): 43-52, 2021.

Topics relevant to development of "SKILL": System design for achieving Sustainable Development Goals.

Catalogue prepared by	Dr. Divya Rani/Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS NO: 17Th BoS meeting held on 5th July 2023
Date of Approval by the	Academic Council Meeting No. 21

Academic Council	

<table>
<tr><td>Course Code:
ECE2011</td><td colspan="3">Course Title: Innovative Projects using Raspberry Pi</td><td>L- T-P-C</td><td>-</td><td>-</td><td>-</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">This course is designed to provide an in-depth understanding of Raspberry-pi Single Board Computers and their application in various real time projects involving sensors. Throughout the course, students will learn Raspberry-pi programming and gain hands-on experience with a wide range of sensors. Students will explore how to connect and interface sensors with Raspberry-pi, read sensor data, and use it to control various output devices This course is suitable for advance learners who are interested in exploring the world of electronics and developing practical applications using Raspberry-pi and sensors.</td></tr>
<tr><td>Course Objective</td><td colspan="8">This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies by using sensors and their interfacing to solve real-time problems .</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of the course the students shall be able to
5) Understand the concept of micro python
6) Explain the main features of the Raspberry-pi prototype board
7) Analyse the hardware interfacing of the peripherals to a Single board computer system.
8) Demonstrate the functioning of live projects carried out using Raspberry-pi system</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Micro python</td><td>Hands-on</td><td colspan="3">Interfacing Task and Analysis</td><td>4 Sessions</td></tr>
<tr><td colspan="9">Topics:
Introduction to Micro Python, Comparison with other programming languages, Setting up the Micro Python development environment, Basics of Micro Python syntax and structure.</td></tr>
<tr><td>Module 2</td><td colspan="2">Working with Raspberry-pi</td><td>Hands-on</td><td colspan="3">Interfacing Task and Analysis</td><td>4 Sessions</td></tr>
<tr><td colspan="9">Introduction to raspberry pi boards, pin-diagram, different types of raspberry pi boards and its application, LED and switch control. Mastering Modules, Setup Raspberry - PuTTY SSH,VNC Viewer to interface with more complicated sensors and actuators. Various Libraries and its functions.</td></tr>
<tr><td colspan="9">Topics: Micro Python, types of Raspberry-pi boards, sensors, 3D Printer</td></tr>
<tr><td colspan="9">Targeted Application & Tools that can be used:
Application Area:
Home Automation, Environmental Monitoring, Agriculture and Farming, Industrial Automation, Internet of Things (IoT), Robotics, Wearable Devices, Security Systems, Education and Learning. These are just a few examples of the many application areas where Arduino and sensors can be applied. The flexibility and affordability of Arduino, combined with the wide</td></tr>
</table>

range of sensors available, allow for endless possibilities in creating innovative projects.
Professionally Used Software: students can use open SOURCE Softwares Thonny Python, Python IDLE etc.

Project work/Assignment:

1. Projects: At the end of the course students will be completing the project work on solving many real time problems.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a presentation from interdisciplinary students group, where the students will be given a project on they have to demonstrate the working and discuss the applications for the same

Textbook(s):

Monk Simon "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", Publisher(s): O'Reilly Media, Inc. ISBN: 9781098130923 fourth Edition.

References

Reference Book(s)

1. Charles Bell Micro Python for the Internet of Things: A Beginner's Guide to Programming with Python on Microcontrollers" by" Edition 1, 2017, ISBN 978-1-4842-3123-4

2. Stewart Watkiss "Learn Electronics with Raspberry Pi " Apress Berkeley, CA . second edition,2020. ISBN978-1-4842-6348-8

Online Resources (e-books, notes, ppts, video lectures etc.):

4. Raspberry-pi Projects < https://magpi.raspberrypi.com/articles/category/tutorials/>
5. Introduction to internet of things< https://nptel.ac.in/courses/106105166>
6. Case studies on Wearable technology< https://www.hticiitm.org/wearables>

E-content:

5. Basil, Eliza Sawant, S.D. "IoT based traffic light control system using Raspberry Pi " DOI 10.1109/ICECDS.2017.8389604

6. Supriya S, 2Dr. Aravinda " Green leaf disease detection and identification using Raspberry Pi https://www.irjet.net/archives/V9/i8/IRJET-V9I847.

7. Dr. E.N. Ganesh., "Health Monitoring System using Raspberry Pi and IOT" DOI : http://dx.doi.org/10.13005/ojcst12.01.03

Topics relevant to development of "SKILL": System design for achieving Sustainable Development Goals.

Catalogue prepared by	Dr. Divya Rani /Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS NO: 17Th BoS meeting held on 5th July 2023
Date of Approval by the Academic Council	Academic Council Meeting No. 21

Course Code: PIP2xxx	**Course Title: Capstone Project** **Type of Course: NTCC**	**L- T-P- C**	-	-	-	8
Version No.	**2.0**					
Course Pre-requisites	**Knowledge and Skills related to all the courses studied in previous semesters.**					
Anti-requisites	**NIL**					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work or Dissertation at the university, or Project Work in an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain **Employability Skills** through **Experiential Learning** techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the engineering problems related to local, regional, national or global needs. 2. Apply appropriate techniques or modern tools for solving the intended problem. 3. Design the experiments as per the standards and specifications. 4. Interpret the events and results for meaningful conclusions. 5. Appraise project findings and communicate effectively through scholarly publications.					
Catalogue prepared by	Dr Joshi Manohar V					
Recommended by the Board of Studies on	BoS No: 17th , held on 06/07/23					
Date of Approval by the Academic Council	21st Academic Council Meeting					

Course Code: PIP4xxx	**Course Title: Internship** **Type of Course: NTCC**	**L- T-P- C**	-	-	-	4
Version No.	**2.0**					
Course Pre-requisites	**Knowledge and Skills related to all the courses studied in previous semesters.**					
Anti-requisites	**NIL**					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work or Dissertation at the university, or Project Work in an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain **Employability Skills** through **Experiential Learning** techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the engineering problems related to local, regional, national or global needs. 2. Apply appropriate techniques or modern tools for solving the intended problem. 3. Design the experiments as per the standards and specifications. 4. Interpret the events and results for meaningful conclusions. 5. Appraise project findings and communicate effectively through scholarly publications.					
Catalogue prepared by	Dr Joshi Manohar V					
Recommended by the Board of Studies on	BoS No: 17th , held on 06/07/23					
Date of Approval by the Academic Council	21st Academic Council Meeting					

PROGRAM CORE

Course Code: ECE2004_v02	**Course Title:** Network Theory **Type of Course:** Program Core & Theory only	**L-T-P-C**	**2**	**1**	**0**	**3**
Version No.	2.0					
Course Pre-requisites	**Fundamental concepts of Electrical Components and Laws like Ohm's and Kirchhoff's laws. Basic knowledge of differential & integral calculus and Linear algebra. Methods of solving Differential equations.**					
Anti-requisites	**NIL**					
Course Description	This Course aims at obtaining the solutions to problems in electrical networks, using network reduction techniques and source transformations. The course also focuses on identifying and solving problems in electric circuits by applying network theorems. **The course is conceptual and is an introductory level course and introduces students to the concepts of** two port networks, behaviour under transient conditions.					
Course objective	**The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Discuss** various network reduction techniques. 2. **Verify** various network theorems. 3. **Summarize** the behavior of RL, RC circuits 4. **Demonstrate** Series and Parallel Combination of Passive Components as resonating circuits, related parameters and analyze frequency response 5. **Illustrate the operation of** two-port networks.					
Course Content:						
Module 1	**Network Reduction Techniques and Source transformation**	Assignment/ Quiz	Problem Solving task	**13 Sessions**		
Topics: Types of electric circuit elements and sources, Source transformation, Mesh analysis, Super mesh analysis, Nodal analysis, Super node analysis, Star and delta transform, Loop and node analysis with linearly dependent and independent sources for DC and AC networks						
Module 2	**Network Theorems**	Assignment/ Quiz	Simulation task	**10 Sessions**		
Topics: Network Theorems, Explanation of Superposition, Thevenin's, Norton and Maximum power transfer theorems and numerical examples on the same.						
Module 3	**Transient analysis**	Assignment	Simulation task	**10 Sessions**		
Topics: Initial conditions, transient analysis of RL, RC circuits in time and frequency domains using Laplace transforms Resonance: Series and parallel resonance, frequency- response of series and Parallel circuits, Q–Factor, Bandwidth, Circuit Magnification Factor						

Module 4	Two-portnetworks Assignment	Problem Solving task	9 Sessi

Topics:
Introduction to Two-port networks, Z-Parameter, Y-Parameter, ABCD Parameter, H-Parameter and Transmission parameters, modelling with these parameters, relationship between parameters sets.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
This course will lay a foundation for all applications of circuit analysis. The knowledge gained from this course will find applications in other courses like LIC, Transmission Lines, Analog communications etc. Students will be able to find a career in various domains like Circuit Design, Communication and Networking, Hardware domain etc

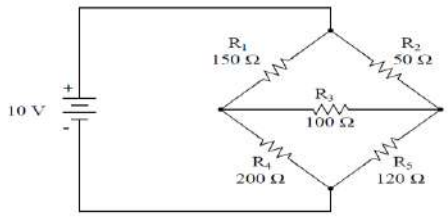
Professionally Used Software: Pspice, Multisim

Project work/Assignment:

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

Presentation: There will be a group presentation on the topics Breadth-first search, Algorithms for Constraint-graph Compaction, Placement Algorithms Assignment, Routing Algorithms, where the students have to explain/demonstrate the working and discuss the applications for the same.

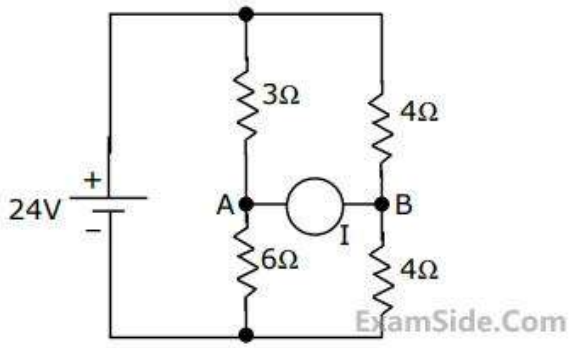
Assignment:
1. Solve network problems by applying Superposition/ Thevenin's/ Norton's/ Maximum Power Transfer Network Theorems and electrical laws to reduce circuit complexities and to arrive at feasible solutions.
2.Calculate current and voltages for the given circuit under transient conditions
3.Apply Laplace transform to solve the given network
4. Solve the given network using specified two port network parameter like Z or Y or T or h.
5. Verification of ohm's law, KCL and KVL using Pspice.
6. It is possible to calculate the proper values of resistors necessary to form one kind of network delta or star (Δ or Y) that behaves identically to the other kind. A prime application for Δ-Y conversion is in the solution of unbalanced bridge circuits, such as the one below:



a. List the number of star and delta connections in the bridge circuit.
b. Find the total current which flows through the circuit using Δ-Y conversion.

2. For maximum power transfer between two cascaded sections of an electrical network, the relationship between the output impedance Z1 of the first section to the input impedance Z2 of the second section is

3. In the circuit shown in Fig., it is known that the variable current source I absorbs power.Find I (in magnitude and direction) so that it receives maximum power and also find the amount of power absorbed by it.



Text Book(s):

1. Ravish.R.Singh, "Electrical Networks", Mcgraw Hill company,2009
2. J.A.Edminister, "Theory and Problems of Electric Circuits", Schaum's Outline Series, 4th Edition.

References:

3. G.K.Mittal, "Network Analysis,Khanna", Publishers,8th edition.
4. Van Valkenberg, "Network Analysis", Prentice Hall, 1974. PHI.

Online and Web Resource (s):

1. NPTEL video lecture by Prof. Tapas Kumar Bhattacharya, Department of Electrical Engineering, IIT Kharagpur:

https://archive.nptel.ac.in/courses/108/105/108105159/

2. NPTEL video lecture by Prof A. Mukharjee

https://nptel.ac.in/courses/106105154

3. NPTEL assignments: https://archive.nptel.ac.in/courses/108/105/108105159/

4. Presidency Library Link:- https://presiuniv.knimbus.com/user#/home

E-Content:

1. Ferran Reverter, Manel Gasulla, "A Novel General-Purpose Theorem for the Analysis of Linear Circuits", IEEE Transactions on Circuits and Systems II: Express Briefs, vol.68, no.1, pp.63-66, 2021.
https://ieeexplore.ieee.org/document/9112277
2. Kirchhoff's laws and Tellegen's theorem for networks and continuous media, IEEE Transactions on Circuits and Systems (Volume: 31, Issue: 7, July 1984)
https://ieeexplore.ieee.org/document/1085549
3. G. Litjens, T. Kooi, B. Ehteshami, Bejnordi, A. A. A. Setio, F. Ciompi, et al., "A survey on deep learning in medical image analysis", *Medical Image Analysis*, vol. 42, pp. 60-88, 2017.
https://pubmed.ncbi.nlm.nih.gov/28778026/
4. A New Method for Generating a Function of Two Independent Variables, IRE Transactions on Electronic Computers (Volume: EC-6, Issue: 3, September 1957)
https://ieeexplore.ieee.org/abstract/document/5222014

Topics related to development of "EMPLOYABILITY": Network Theorems and Transient Analysis
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Two-port networks
Topics related to development of "ENTREPRENEURSHIP":Two-port networks

Catalogue prepared by	Mrs. Aruna M
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE2002_v02	**Course Title: Digital Electronics Type of Course: Program Core Theory &Integrated Laboratory**	**L- T-P- C**	**2**	**1**	**2**	**4**
Version No.	2.0					
Course Pre-requisites	**[1] Elements of Electronics/Electrical Engineering, 2] Basic concepts of number representation, Boolean Algebra**					
Anti-requisites	**NIL**					
Course Description	**Digital Electronics: Learning of basics in digital electronic circuits that are used to process the digital signals. The course is designed to be one of the core course in electronics/ electrical engineering. Successful completion will provide the necessary foundation for more specialist learning in digital microelectronics, computer and communication engineering. The purpose of this course is to support the students to exhibit the Boolean Logic. The course is analytical in nature and needs fair knowledge of Boolean Theorems. The course shields theory and laboratory for Digital Electronics including basic principles, analysis and design.** **Further it covers the different methods of Boolean function simplification- Study and classification of Digital circuits- Design and Implementations of Digital Logic circuits-Programmable logic circuit** **The course also enhances the Design, Implementation and Programming abilities through laboratory assignments. The associated laboratory provides an opportunity to certify the theoretic knowledge.**					
Course Objective	**The objective of the course is <u>SKILL DEVELOPMENT</u> of the student by using <u>PARTICIPATIVE LEARNING</u> techniques.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** i. **Discuss** the concepts of number systems, Boolean algebra and logic gates. ii. **Apply** minimization techniques to simplify Boolean expressions. iii. **Demonstrate** the Combinational circuits for a given logic iv. **Illustrate** the Sequential and programmable logic circuits v. **Implement** various combinational logic circuits using gates. vi. **Verify** the performance of various sequential logic circuits using gates.					
Course Content:						
Module 1	**Fundamentals of Number systems- Boolean algebra and digital logic**	Application Assignment	Data Analysis task	**8 classes**		
Topics: Introduction to Number systems, Number base conversions, complement of numbers, Binary Codes, Boolean theorems and Boolean algebra, Boolean functions- canonical and standard forms, Digital logic gates. **[Bloom's level selected: Knowledge]**						

Module 2	**Boolean function simplification**	Application Assignment	Data Analysis task	**12 Classes**
Topics: Introduction, two variable, three variable, four variable K-Map - Don't care conditions. - NAND & NOR Implementation. **[Bloom's level selected: Application]**				
Module 3	**Combinational Logic circuits:**	Application Assignment	Programming Task & Data Analysis task	**10 Classes**
Introduction to Combinational circuits, Analysis, Design procedure, Binary Adder and Subtractor, Magnitude comparator, Multiplexers-Demultiplexers, Encoders - Decoders, HDL Models of combinational circuits. **[Bloom's level selected: Application]**				
Module 4	**Sequential and Programmable logic circuits:**	Application Assignment	Programming Task	**15 Classes**
Introduction to sequential circuits, Storage elements: latches and flip flops, Characteristic tables, characteristic equations, excitation table, Analysis of clocked sequential circuits, Mealy & Moore Models of finite state machines- Registers & Counters - HDL Models of Sequential circuits- ROMs, PLDs & PLAs. **[Bloom's level selected: Application]**				
List of Laboratory Tasks: **Experiment N0 1:** Verify the Logic Gates truth table **Level 1: By using Digital Logic Trainer kit** **Level 2: By using Analog devices like RPS, Volt meter, Resistors and ICs** **Experiment No. 2:** Verify the Boolean Function and Rules **Level 1: By using Digital Logic Trainer kit** **Level 2: By using Analog devices like RPS, Volt meter, Resistors and ICs** **Experiment No. 3:** Design and Implementations of HA/FA **Level 1: By using basic logic gates and Trainer Kit** **Level 2: By using Universal logic gates and Trainer Kit** **Experiment No. 4:** Design and Implementations of HS/FS **Level 1: By using basic logic gates and Trainer Kit** **Level 2: By using Universal logic gates and Trainer Kit** **Experiment No. 5:** Design and Implementations of combinational logic circuit for specifications **Level 1: Specifications given in the form of Truth table** **Level 2: Specification should be extracted from the given scenario** **Experiment No. 6:** Study of Flip flops **Experiment No. 7:** Design and Implementations of synchronous counter using JK flipflop **Level 1: TWO bit up counter/Down counter** **Level 2: FOUR bit up counter/Down counter** **Experiment No.8:** HDL coding for basic combinational logic circuits **Level 1: Gate level Modeling** **Level 2: Behavioral Modeling** **Experiment No.9:** HDL coding for basic sequential logic circuit **Level 1: Gate level Modeling** **Level 2: Behavioral Modeling**				
Targeted Application & Tools that can be used: **Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, Home Automation, Communication in systems in industries**				

Professionally Used Software: HDL/VHDL/Verilog HDL/ OOPS

Project work/Assignment:

Project Assignment:
Using Seven Segment Display unit, display the Numbers between 0 to 9.
Assignment: 1]
An Engine has 4 failsafe sensors. The Engine should keep running unless any of the following conditions arise:

- If sensor 1 is activated.
- If sensor 2 and sensor 3 are activated at the same time.
- If sensor 4 and sensor 3 are activated at the same time.
- If sensors 2, 3, 4 are activated at the same time.

Apply minimization technique to get the simplified Boolean expression.
Assignment 2]:
A digital system is to be designed in which the month of the year is given as input is four bit form. The month January is represented as '0000', February '0001' and so on. The output of the system should be '1' corresponding to the input of the month containing 31 days or otherwise it is '0'. Consider the excess numbers in the input beyond '1011' as don't care conditions for system of four variables (A, B, C, D). Design the simplified logic expression using Universal gates
Assignment 3]:
"At the outset, to design circuits we used Analog Devices. In the digital era, we are using gates and flip-flop for fast computing and reduce circuit size. Electronic circuits that count events and provide a digital output with increments for each input cycle is known as counter." A digital synchronous sequential circuits needed for the purpose of counting the binary input values in ascending manner. Initially think about four bit binary number. Initial state is 0000 and final state is 1111, After getting final state, the circuit should start counting over from initial state (4 bit UP counter). You are provided with JK flip flop and all possible basic gates with working conditions. Through the state table and K map simplification, design a circuit for the specification.

Text Book(s):

1. Mano, M. Morris and Ciletti Michael D., *"Digital Design"*, Pearson Education, 6th edition
2. Thomas L. Floyd "DIGITAL LOGIC DESIGN" , Pearson Education, fourth edition.

Reference(s):
Reference Book(s):

R1. Jain, R. P., *"Modern Digital Electronics",* McGraw Hill Education (India), 4th Edition

R2. Roth, Charles H., Jr and Kinney Larry L., *"Fundamentals of logic Design"*, Cengage Learning, 7th Edition

Online Resources (e-books, notes, ppts, video lectures etc.): Book Free Download (studymaterialz.in)

1. **eBook1**: Mano, M. Morris and Ciletti Michael D., *"Digital Design"*, Pearson Education.
2. {[PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download }
3. **eBook2:**Floyd "DIGITAL LOGIC DESIGN" fourth edition- ePub, eBook- [PDF] DIGITAL LOGIC DESIGN FOURTH EDITION FLOYD | abri.engenderhealth.org.
4. NPTEL Course- NPTEL :: Electrical Engineering - NOC:Digital Electronic Circuits
5. Digital Logic Design PPT Slide 1 (iare.ac.in)
6. Lab Tutorial: Multisim Tutorial for Digital Circuits - Bing video
   CircuitVerse - Digital Circuit Simulator online
   Learn Logisim ➠ Beginners Tutorial | Easy Explanation! - Bing video
   Digital Design 5: LOGISIM Tutorial & Demo

7.https://presiuniv.knimbus.com/user#/home

E-content:

1. Z. Xin-Li and W. Hong-Ying, "The Application of Digital Electronics in Networking Communication," 2016 Eighth International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), 2016, pp. 684-687, doi: 10.1109/ICMTMA.2016.168.
2. An encoding technique for design and optimization of combinational logic circuit Dipayan Bhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;Kazuyuki Murase 2010 13th International Conference on Computer and Information Technology (ICCIT)
3. A. Matrosova and V. Provkin, "Applying Incompletely Specified Boolean Functions for Patch Circuit Generation," 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-4, doi: 10.1109/EWDTS52692.2021.9581029.
4. A. Matrosova, V. Provkin and E. Nikolaeva, "Masking Internal Node Faults and Trojan Circuits in Logical Circuits," *2019 IEEE East-West Design & Test Symposium (EWDTS)*, 2019, pp. 1-4, doi: 10.1109/EWDTS.2019.8884434.

Topics related to development of " **SKILL DEVELOPMENT** ": Adders, Multiplexers, Decoders / Encoders; Flip-Flops, Counters and Registers.

Catalogue prepared by	Dr.G.Muthupandi
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE2012	**Course Title: Solid State Electronics** **Type of Course: Program Core**	**L-T-P-C**	**3**	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic of semiconductor					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to provide students with a sound understanding of existing semiconductor devices, so that their studies of electronic circuits and systems will be meaningful and to develop the basic tools with which they can later learn about newly developed devices and applications.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	**On successful completion of this course the students shall be able to:** CO1 Describe and illustrate the Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors. CO2 Sketch and explain the Carrier Transport Phenomena in semiconductor. CO3 Illustrate with the sketch of the structure of PN Junction and Junction Diodes diagram their characteristics and analyse them. CO4 Appraise the principle of operation BJTs, schematize their characteristics, assess and summarize their features. CO5 Schematize the structure and design Field Effect Transistors. Schematize their characteristics and prepare an inference.					
Course Content:						
Module 1	Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors:	Quiz	Memory Recall based Quizzes		**12 session**	
Topics: Quantum Mechanics, Bonding Forces and Energy Bands in Solids, Direct and Indirect Semiconductors, LED, Variation of Energy Bands with Alloy Composition, Effective Mass, Electrons and Holes in Quantum Wells, Gunn Diode, Temperature Dependence of Carrier Concentrations, Conductivity and Mobility, High-Field Effects, The Hall Effect. Excess Carriers in Semiconductors: Optical Absorption, Luminescence, Carrier Lifetime and Photoconductivity, Solar Cells; Diffusion of Carriers: Diffusion Processes, Diffusion and Drift of Carriers; Built-in Fields, Diffusion and Recombination; The Continuity Equation, Steady State Carrier Injection; Diffusion Length, The Haynes–Shockley Experiment.						
Module 2	**PN Junction and Junction Diodes:**	Assignment / Quiz	Programming task		**11 session**	
Topics: Charge at Junction, Contact Potential, Capacitance of p-n Junctions, Reverse-Bias Breakdown,						

Zener diode, Varactor Diode, Effects of Contact Potential on Carrier Injection, Recombination and Generation in Transition Region, Metal– Semiconductor Junctions, PIN diodes, Step Recovery Diodes, IMPATT diodes,

Tunnel Diode.

Module 3	**Bipolar Junction Transistor (BJT)**	Assignment	Memory Recall based Quizzes	**12 session**

Topics:
Fundamentals of BJT Operation, Amplification with BJTs, Minority Carrier Distributions and Terminal Currents, Drift in the Base Region, Base Narrowing, Avalanche Breakdown, Gummel–Poon Model, Kirk Effect; Frequency Limitations of Transistors, High-Frequency Transistors, Heterojunction Bipolar Transistors.

Module 4	**Field-Effect Transistors**	Assignment	Programming task	**10 session**

Topics:
Junction FET, GaAs MESFET, High Electron Mobility Transistor (HEMT); Metal–Insulator–Semiconductor FET, MOSFET: Output Characteristics, Transfer Characteristics, Mobility Models, Short Channel MOSFET I–V Characteristics, Threshold Voltage Expression, Substrate Bias Effects, Subthreshold

Characteristics, Equivalent Circuit for the MOSFET, CMOS processes.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Application Area includes all electronic devices (regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves Basic to high level of electronic circuit designer and study their behavior.

Professionally Used Software: SPICE modelling/ Multisim/ LT spice

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Implementation of various concepts from semiconductor devices using Multisim/spice implementation.

Text Book(s):

1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
2. J. P. Colinge, C. A. Colinge, "Physics of Semiconductor Devices", Springer Science & Business Media, 2007.

Reference(s):
Reference Book(s):

1. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience,

2006.
2. Donald A. Neamen, Dhrubes Biswas "Semiconductor Physics and Devices", 4/e, McGrawHill Education, 2012

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://archive.nptel.ac.in/courses/117/106/117106091/
2. https://archive.nptel.ac.in/courses/115/105/115105099/

E-content:

7. K. Shenai, M. Trivedi and P. G. Neudeck, "Characterization of hard- and soft-switching performance of high-voltage Si and 4H-SiC PiN diodes," in *IEEE Transactions on Electron Devices*, vol. 49, no. 9, pp. 1648-1656, Sept. 2002, doi: 10.1109/TED.2002.802645. https://ieeexplore.ieee.org/document/1027855
8. H. J. Barnaby, B. Vermeire and M. J. Campola, "Improved Model for Increased Surface Recombination Current in Irradiated Bipolar Junction Transistors," in *IEEE Transactions on Nuclear Science*, vol. 62, no. 4, pp. 1658-1664, Aug. 2015, doi: 10.1109/TNS.2015.2452229. https://ieeexplore.ieee.org/document/7182367
9. X. Zhao, A. Vardi and J. A. del Alamo, "Excess OFF-State Current in InGaAs FinFETs: Physics of the Parasitic Bipolar Effect," in *IEEE Transactions on Electron Devices*, vol. 66, no. 5, pp. 2113-2118, May 2019, doi: 10.1109/TED.2019.2903912. https://ieeexplore.ieee.org/document/8672824
10. Y. -C. Chang, J. -K. Sheu and Y. -L. Li, "Sub-Bandgap Laser Light-Induced Excess Carrier Transport Between Surface States and Two-Dimensional Electron Gas Channel in AlGaN/GaN Structure," in *IEEE Journal of Quantum Electronics*, vol. 46, no. 1, pp. 112-115, Jan. 2010, doi: 10.1109/JQE.2009.2029065. https://ieeexplore.ieee.org/document/5357483

Topics related to development of "FOUNDATION": Energy Bands, Charge Carriers in Semiconductors, the Hall Effect, Diffusion of Carriers, PIN diodes, Step Recovery Diodes, IMPATT diodes, BJT, FET
Topics related to development of "EMPLOYABILITY": MESFET, HEMT, CMOS

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE2013	**Course Title: Digital System Design using HDL** **Type of Course Professsional Core**	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basic concepts on Logic Design Fundamentals, FPGA				
Anti-requisites	NIL				
Course Description	The purpose of this course is to enable the students to understand verilog HDL and develop digital circuits using gate level and data flow modeling. The course focuses on designing combinational and sequential building blocks, using these building blocks to design bigger digital systems. During this course we also learn how to use Verilog to design/model a digital system. This course builds on logic design principles learned in Digital Logic Design and demonstrates how digital design and rapid prototyping have been facilitated by HDLs (Hardware Description Languages) and FPGAs (Field Programmable Gate Arrays).				
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.				
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the basic concepts of Digital Design 2. Implement various Combinational and sequential circuits using VHDL descriptions. 3. Design and verify the functionality of digital circuits (PLA, PAL, PLD) and Arithmetic Operations. 4. Identify the suitable Abstraction level for a particular digital design.				
Course Content:					
Module 1	**Review of Logic Design Fundamentals**	Quiz	Memory Recall based Quizzes	**12 session**	
Topics: Combinational logic, Boolean Algebra and Algebraic Simplification, Karnaugh maps, Designing with NAND and NOR gates, Hazards in combinational Networks, Flipflop and Latches, Mealy Sequential Network Design, Design of Moore Sequential Network, Equivalent states and reduction of state Tables, Synchronous Design, Tristate Logic and Buses.					
Module 2	**Introduction to VHDL**	Assignment / Quiz	Programming task	**12 session**	
Topics: VHDL Description of Combinational Networks, Modeling Flip flops using VHDL Processes, VHDL Models for a Multiplexer, Modeling a sequential Machine, Variables, signals, and constants, Arrays, VHDL operators, VHDL Functions, VHDL Procedures, Packages and Libraries.					
Module 3	**Styles of Descriptions**	Assignment	Memory Recall based Quizzes	**10 session**	
Topics: VHDL Data types, VHDL Styles of Description Data flow Description: Highlights of Data flow Description, Structure of Data flow Description, Data type-vectors, Common VHDL programming Errors					
Module 4	**Designing with programmable**	Assignment	Programming task	**09 session**	

	Logic Devices			

Topics:
Read only memories, Programmable Logic Arrays, Programmable Array Logic, Other sequential programmable Logic Devices (PLDs), Generics, Generate statements. Design of Networks for Arithmetic Operations: Design of serial Adder with Accumulator, Design of Binary Multiplier, Multiplication of signed Binary Numbers, Design of Binary Divider

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Modelling a digital system in Verilog HDL, Chip design
Professionally Used Software: Cadence design suite, VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Synthesizing information from entity and module and Mapping of signal variables in the hardware domain.

Text Book(s):

3. "Digital Systems Design using VHDL", Charles H. Roth, Jr., The University of Texas at Austin. 2006 reprint, Thomson Asia Pte Ltd, Singapore

Reference(s):
Reference Book(s):

1. "HDL Programming VHDL and Verilog", Nazeih M. Botros, 2009 reprint, Dreamtech press
2. VHDL for Programmable Logic", Kevin Skahill, Pearson education, 2006

Online Resources (e-books, notes, ppts, video lectures etc.):

1. **https://uevent.utp.edu.my/digital-system-design/**
2. **https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SECA3021.pdf**
3. **https://www.pearsonhighered.com/assets/samplechapter/0/1/3/0/0130449113.pdf**
4. **https://www.youtube.com/watch?v=w3jNkZ-5s-U**
5. **https://www.digimat.in/nptel/courses/video/117108040/L01.html**

E-content:

1. A. Mathur *et al*., "HDL generation from parameterized schematic design system," *Proceedings. Tenth Annual IEEE International ASIC Conference and Exhibit (Cat. No.97TH8334)*, Portland, OR, USA, 1997, pp. 130-134, doi: 10.1109/ASIC.1997.616992.
https://ieeexplore.ieee.org/document/616992

2. A. Atac *et al*., "An HDL-based system design methodology for multistandard RF SoC's," *2014 51st ACM/EDAC/IEEE Design Automation Conference (DAC)*, San Francisco, CA, USA, 2014, pp. 1-6.
https://ieeexplore.ieee.org/document/6881494

3. W. Burleson and Sheng Xu, "Digital systems design with ASIC and FPGA: a novel course using CD/DVD and on-line formats," *2005 IEEE International Conference on Microelectronic Systems Education (MSE'05)*, Anaheim, CA, USA, 2005, pp. 3-4, doi: 10.1109/MSE.2005.27.
https://ieeexplore.ieee.org/document/1509336

4. J. D. Lynch, D. Hammerstrom and R. Kravitz, "A cohesive FPGA-based system-on-chip

design curriculum," *2005 IEEE International Conference on Microelectronic Systems Education (MSE'05)*, Anaheim, CA, USA, 2005, pp. 17-18, doi: 10.1109/MSE.2005.5. **https://ieeexplore.ieee.org/document/1509343**						
Topics related to development of "FOUNDATION": Modeling Flip flops using VHDL Processes Topics related to development of "EMPLOYABILITY": Designing with programmable Logic Devices						
Catalogue prepared by	Ms. Maitraiyee Konar					
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024					
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024					
Course Code: ECE3109	**Course Title: Signal Processing** **Type of Course: Professsional Core**	**L-T-P-C**	**3**	**0**	**0**	**3**
Version No.	1.0					
Course Pre-requisites	An understanding of basic concepts of linear circuits as examples of linear systems, Concepts of Matrices.					
Anti-requisites	**NIL**					
Course Description	This course will teach signal/system properties, sampling, frequency transforms and responses, feedback, control applications as well as computer analysis using MATLAB/Python. The purpose of this course is to prepare students with fundamental knowledge/ overview in the field of Digital Signal Processing to explore the application of various transforms and algorithm in digital signal processing. The course is analytical in nature and needs fair knowledge of Discrete Mathematics and Computational logic to understand the basic principles, operations and algorithms of digital signal processing. This course enhances students' abilities to follow future courses in Signal Processing Specialization like Biomedical Signal Processing, Multimedia Signal Processing, Audio Signal Processing etc.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: i) Understand basic concepts of discrete-time signals and linear time invariant (LTI) systems to provide their time-domain and frequency-domain descriptions. ii) Analyse different types of signals and the properties of discrete-time signals & systems iii) Describe the basic concepts of DSP with Discrete Fourier Transforms and the FFT algorithm for the discrete sequence. iv) Compute DFT using FFT algorithms. v) Design FIR and IIR Digital Filters.					
Course Content:						
Module 1	**Introduction and Classification of signals**	Assignment / Quiz	Memory Recall based Quizzes/ Programming and Simulation task	**12 session**		
Definition of signal and systems with examples, Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions. **Basic Operations on signals**: Amplitude scaling, addition, multiplication, time scaling, time shift and time reversal. Expression of triangular, rectangular and other waveforms in terms of						

elementary signals System Classification and properties: Linear-nonlinear, Time variant - invariant, causal-noncausal, static-dynamic, stable-unstable, invertible.				
Module 2	**Time domain representation of LTI System:**	Assignment / Quiz	Memory Recall based Quizzes/ Programming and Simulation task	10 ***Sessions***
Impulse response, convolution sum. Computation of convolution sum using graphical method for unit step and exponential, exponential and exponential, unit step and rectangular. **LTI system Properties in terms of impulse response:** System interconnection, Memory less, Causal, Stable, Invertible and Deconvolution and step response. **The Z-Transforms:** Z transform, properties of the region of convergence, properties of the Z-transform, Inverse Z-transform by partial fraction, Causality and stability, Transform analysis of LTI systems.				
Module 3	**Discrete Fourier Transforms (DFT) and FFT Algorithms**	Application Assignment	Data Analysis task	**10** ***Sessions***
Discrete Fourier Transforms (DFT): Frequency domain sampling and Reconstruction of Discrete Time Signals, The Discrete Fourier Transform, DFT as a linear transformation, Properties of the DFT: Periodicity, Linearity and Symmetry properties, Multiplication of two DFTs and Circular Convolution **Additional DFT Properties, Linear filtering methods based on the DFT:** Use of DFT in Linear Filtering, Filtering of Long data Sequences. Fast-Fourier-Transform (FFT) algorithms: Efficient Computation of the DFT: Radix-2 FFT algorithms for the computation of DFT and IDFT decimation in-time				
Module 4	**Design of FIR and IIR Filters**	Application Assignment	Data Analysis task	**13** ***Sessions***
Design of FIR Filters: Characteristics of practical frequency-selective filters, Symmetric and Anti-symmetric FIR filters, Design of Linear-phase FIR (low pass and High pass) filters using windows - Rectangular, Hamming, Hanning. Structure for FIR Systems: Direct form, Cascade form and Lattice structures **IIR Filter Design:** Infinite Impulse response Filter Format, Bilinear Transformation Design Method, Analog Filters using Low pass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation and Frequency Warping, Bilinear Transformation Design Procedure, Digital Butterworth (Lowpass and Highpass) Filter Design using BLT				
Targeted Application & Tools that can be used: **Application Area** includes signal processing, networks, communication, data science, machine learning, control system design. **Professionally Used Software: Matlab/Python / Code Composer Studio/ Octave/SciPy** **Besides these software tools hardware equipment such as DSP Kits are used for validation purpose.**				
1. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . **2. Presentation:** There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. **3. Project Assignment**:- Implementation of various concepts in Signals and Systems using MATLAB/ SIMULINK. Activity Based Learning (Suggested Activities in Class)/ Programming Assignments / Mini Projects can be given to improve programming skills				

Text Book(s):

1. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN9971-51- 239-4.
2. Proakis & Manolakis, "Digital Signal Processing - Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
3. Li Tan, Jean Jiang, "Digital Signal processing - Fundamentals and Applications", Academic Press, 2nd Edition ,2013, ISBN: 978-0-12-415893.

References:

Reference Book(s):

1. B P Lathi, "Linear Systems and Signals", Oxford University Press, 2005.
2. Ganesh Rao and Satish Tunga, "Signals and Systems", 2nd Edition Pearson/Sanguine.
3. Michael Roberts, "Fundamentals of Signals & Systems",2nd edition, Tata McGraw-Hill, 2010, ISBN978-0- 07-070221-9.
4. Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013,
5. Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI, 2003.
6. D Ganesh Rao and Vineeth P Gejji, "Digital Signal Processing" Cengage India Private Limited, 2nd Edition ,2017, ISBN: 9386858231

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on Signals and Systems by Alan V Oppenheim
2. Lecture 1 https://www.youtube.com/watch?v=KJnAy6hzetw&list=PL41692B571DD0AF9B
3. Lecture 2 https://www.youtube.com/watch?v=6xaaeop7gJ8&list=PLADC1A1B7FA7FF7B6
4. YouTube NPTEL video lectures signals and system: https://www.youtube.com/watch?v=7Z3LE5uM-6Y&list=PLbMVogVj5nJQQZbah2uRZIRZ_9kfoqZyx
5. Introduction to FFT Digital Signal Processing Tutorial (tutorialspoint.com)
6. Filter Design and Realizations FOR DSP PRESENTATION (wustl.edu)

E-content:

1. L. Santhosh and A. Thomas, "Implementation of radix 2 and radix 22 FFT algorithms on Spartan6 FPGA," *2013 Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT)*, 2013, pp. 1-4, doi: 10.1109/ICCCNT.2013.6726840.
2. *Saeed, Ahmed, et al. "Efficient fpga implementation of fft/ifft processor." International Journal of circuits, systems and signal processing 3.3 (2009): 103-110.*
3. S. Bouguezel, M. O. Ahmad and M. N. S. Swamy, "An Alternate Approach for Developing Higher Radix FFT Algorithms," *APCCAS 2006 - 2006 IEEE Asia Pacific Conference on Circuits and Systems*, 2006, pp. 227-230, doi: 10.1109/APCCAS.2006.342373

Topics related to development of "EMPLOYABILITY SKILLS": DFT & IDFT, FFT & IFFT
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Applications of DSP

Catalogue prepared by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3160**	**Course Title: Communication Systems** **Type of Course: Professional Core**		**L-P-C**	3	2	4
Version No.					
Course Pre-requisites	Basics of analog and digital circuit design, binary operations in digital electronics, basic concept of signals and systems to perform operations on signals, elementary engineering mathematics				
Anti-requisites	NIL				
Course Description	The course deals with the importance and applications of communication engineering for both analog and digital signals, emphasizing on audio, video and image transmission & reception. The course is conceptual and application oriented. This course acts as a foundation for the future courses in communication domain like mobile and wireless communication, data communication and computer networks, satellite communication and advanced internet-of-things. The laboratory experiments integrated with the theory provide an opportunity for the students to validate the concepts learned in theory through experiments and motivate the students to extend such laboratory experiments to real life applications.				
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Communication Engineering and attain the SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.				
Course Outcomes	On successful completion of this course the students shall be able to: 1] Discuss and differentiate the working principles of various amplitude modulation methods. 2] Describe the techniques of frequency modulation to generate and detect FM waves. 3] Demonstrate various processes involved in digital modulation and demodulation in wireless communications. 4] Implement pulse code modulation technique to convert analog signal into binary data. 5] Carry out spread spectrum modulation method to understand the basics of advanced wireless communication.				
Course Content:					
Module 1	Introduction to Communication Engineering	Assignment	Simulation task: design of general AM, DSB-SC and SSB-SC waveforms in MATLAB & SIMULINK.	**12classes**	
Topics: Introduction: Elements of communication systems, modulation methods and its requirements, amplitude modulation & demodulation: DSB-FC (AM) modulation & its demodulation, generation of AM signals, sideband and carrier power of AM, double sideband suppressed carrier (DSB-SC) modulation & its demodulation, single sideband (SSB) transmission, generation of SSB signals, Comparison of various amplitude modulation techniques, illustrative numerical problems.					
Module 2	Angle modulation and demodulation	Case Study	Simulation task: design of general FM and PM waveforms in MATLAB & SIMULINK.	**12 classes**	
Topics: Concept of instantaneous frequency, generalized concept of angle modulation, bandwidth of angle modulated waves – Narrow band frequency modulation (NBFM) and Wide					

band FM (WBFM), generation of FM waves – indirect method and direct method. demodulation of FM signals, illustrative numerical problems.

Module 3	Digital Modulation Techniques	Assignment	Simulation task : design of digital modulation and demodulation techniques using MATLAB & SIMULINK.	**12 classes**

Topics: Block diagram of digital communication system, sampling theorem, practical aspects of sampling and signal recovery, pulse modulation, TDM, PCM and DM concepts, , ISI, Nyquist's criterion for distortion less transmission, illustrative numerical problems, digital modulation formats, coherent and non-coherent binary modulation techniques and waveform study.

Module 4	Spread Spectrum Modulation and Detection & Estimation	Assignment	Simulation task: PN sequence generation using MATLAB and SIMULINK.	**12 classes**

Topics: Pseudo noise sequences, notion of spread spectrum, direct sequence spread spectrum, frequency hop spread spectrum, applications, probability of error (statement only), some applications of DS Spread spectrum signals, generation of PN sequences, illustrative numerical problems.

List of Laboratory Tasks:

Experiment N0 1:

Level1:

Implementation of general amplitude modulation and demodulation.

Level2:

Implementation of general AM using the MATLAB/SIMULINK and study the output by varying the depth of modulation.

Experiment N0 2:

Level1:

Study of AM-DSBSC and SSB-SC modulation and demodulation.

Level2:

Implementation and generation of AM-DSBSC and SSB-SC modulation in MATLAB/SIMULINK and study of waveforms.

Experiment N0 3:

Level1:

Study of frequency modulation and demodulation.

Level2:

Implementation and generation of FM and PM modulation in MATLAB/SIMULINK and study of waveforms **.**

Experiment N0 4:

Level1:

Simulate appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.

Level2:

Rig up the appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment N0 5:

Level1:

Implementation of sampling circuit to convert given analog signal into its samples with sampling frequency $f_s \geq 2f_{max}$ using LT Spice/MATLAB simulation tool.

Level2:

Implementation of sampling circuit to convert given analog signal into its samples with sampling frequency fs≥2fmax using analog and/or digital hardware components.

Experiment N0 6:
Level1:
Simulate the appropriate quantizer circuit to replace the samples of analog signal into its nearest value using LT spice/MATLAB simulation tool
Level2:
Rig up the appropriate quantizer circuit to replace the samples of analog signal into its nearest value using analog and/or digital hardware components.

Experiment N0 7:
Level1:
Implementation of suitable encoder circuit to represent binary data for the quantized samples using LT spice/MATLAB simulation tool
Level2:
Construct suitable encoder circuit to represent binary data for the quantized samples using analog and/or digital hardware components.

Experiment N0 8:
Level1:
Simulate appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.
Level2:
Rig up the appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment No. 9:
Level1:
Simulate appropriate serial to parallel converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.
Level2:
Rig up the appropriate serial to parallel converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment No. 10:
Level1:
Implementation of suitable decoder circuit to represent binary data for the quantized samples using LT spice/MATLAB simulation tool
Level2:
Construct suitable decoder circuit to represent binary data for the quantized samples using analog and/or digital hardware components.

Experiment No. 11:
Level1:
Implementation of reconstruction low pass filter to recover analog signal using LT spice/MATLAB simulation tool.
Level2:
Carry out the reconstruction low pass filter circuit to recover analog signal using analog and/or digital hardware components.

Experiment No. 12:
Level1:
Integration of all the experiments from 1 to 11, for the demonstration of pulse code modulation and demodulation using LT spice/MATLAB simulation tool.
Level2:
Integration of all the experiments from 1 to 11, for the demonstration of pulse code

modulation and demodulation for the given analog signal using analog and/or digital hardware components. Use co-axial or telephone cable as wired channel to establish communication between modulator and demodulator.

Targeted Application & Tools that can be used:

Application Area is transmission and reception of electrical signals, data, voice, image, video, text, scanned documents etc. between the two places through wired or wireless communication using communication engineering components or systems.
Professionally Used Hardware/Software: DSP processor/Arduino/Raspberry PiLTSpice/MATLAB/SIMULINK

Text Book(s):

1. Simon Haykin, "Communication Systems", John Wiley Publication, 2009, 5th Edition.

2. B.P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press 2011, 4th Edition.

Reference(s):

Reference Book(s):

1. B. Sklar, "Digital Communication: Fundamentals and Applications", Pearson Edition, 2nd Edition.

2. Sam Shanmugam, "Digital & Analog Communication K.", John Wiley Publication, 2nd Edition.

3. LT Spice/ MATLAB/SIMULINK software reference manual and for hardware appropriate kit reference manuals, experiments in communication engineering reference manual and data sheets.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. MIT OPEN COURSE:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/
2. MIT PRINCIPLES OF DIGITAL COMMUNICATIONS:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/video-lectures/lecture-1-introduction/
3. MIT PRINCIPLES OF DIGITAL COMMUNICATIONS:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/video-lectures/lecture-6-quantization/
4. MIT PRINCIPLES OF DIGITAL COMMUNICATIONS:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-02-introduction-to-eecs-ii-digital-communication-systems-fall-2012/lecture-videos/lecture-15-modulation-demodulation/
5. Presidency Library Link:-https://presiuniv.knimbus.com/user#/home

E-content:

1. L. S. Schwartz, "Recent developments in digital communications," in Electrical Engineering, vol. 82, no. 6, pp. 415-418, June 1963, doi: 10.1109/EE.1963.6541408. https://ieeexplore.ieee.org/document/6541408
2. M. A. Ben Farah, A. Kachouri and M. Samet, "Design of secure digital communication systems using DCSK chaotic modulation," International Conference on Design and Test of Integrated Systems in Nanoscale Technology, 2006. DTIS 2006., 2006, pp. 200-204, doi: 10.1109/DTIS.2006.1708656. https://ieeexplore.ieee.org/document/1708656

3. Gustavo P. Cainelli, Lisa Underberg, Lutz Rauchhaupt, Carlos E. Pereira, Asset administration shell submodel for wireless communication system., IFAC-PapersOnLine, Volume 55, Issue 2, 2022, Pages 120-125, ISSN 2405-8963, https://doi.org/10.1016/j.ifacol.2022.04.180.
4. Aleksandra Tutueva, Lazaros Moysis, Vyacheslav Rybin, Alexander Zubarev, Christos Volos, Denis Butusov, Adaptive symmetry control in secure communication systems, Chaos, Solitons & Fractals, Volume 159, 2022, 112181, ISSN 0960-0779. https://doi.org/10.1016/j.chaos.2022.112181.

Topics relevant to "SKILL DEVELOPMENT": Sampling, TDM, PCM, DPCM, DM, Digital Modulation, Spread Spectrum for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Saurav Ganguly
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3119	**Course Title: Microcontrollers and Computer Architecture** **Type of Course Professsional Core**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Electronics Devises, Logic Design, 8 bit/16 bit Microprocessor Architecture.					
Anti-requisites	NIL					
Course Description	The course provides insights into the fundamentals of microcontroller and introduces the core principles of computer architecture from basics to intermediate level too understand the interaction between computer hardware and software. It equips the students with the intuition behind assembly-level instruction set architectures.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Discuss the architecture and working principles of 8051 microcontrollers. 2) Demonstrate basic operations and Analyze the 8051 C Microcontroller interfacing with external hardware. 3) Discuss the basic components of a computer, their interconnections, and instruction set architecture 4) Apply appropriate techniques to carry out selected arithmetic operations					
Course Content:						
Module 1	**Fundamentals of Microcontroller 8051:**	**Quiz**	**Memory Recall based Quizzes**	**10 Sessions**		
Topics: Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.						
Module 2	**8051 Instruction Set,Timers and Serial Port:**	**Quiz/ Assignment**	**Programming and Simulation task using ALP/ C**	**14 Sessions**		
Topics: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions., 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication.						
Module 3	**Structure of Computers, Instruction Set Architecture and Memory Unit**	Assignment	Memory Recall based Quizzes	**14 session**		
Topics: Computer Types, Functional Units, Basic Operational concepts, Bus Structures, Computer systems RISC & CISC, Performance, Arithmetic Operations on Signed numbers. Instructions and Instruction Sequencing, Instruction formats, Memory Instructions, Addressing Modes,						

Stacks and Subroutines. Memory System: Basic Concepts, Internal Organization of Memory chips, Read Only Memories, Memory Hierarchy, Cache Memories and Cache mapping Techniques.

List of Laboratory Tasks: Nil

Application area is embedded system design, Instrumentation and Process Control, Consumer Electronics Light sensing & controlling devices, Temperature sensing and controlling devices.

Tools used are µVision IDE from Keil, MCU 8051 IDE.

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based stepper motor and 8051 Microcontroller as a case study. Students will be submitting a report which will include basic programming on ARM in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Assignments on hardware interfacing with programming in C/Assembly language. Mini projects.

5. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format. Presidency University Library Link .

Text Book(s):

4. "The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
5. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", Fifth Edition, McGraw-Hill Higher Education, 2016 reprint.(TB1)

Reference(s):

Reference Book(s):

3. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.
4. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005Seth Weidman "Deep Learning from Scratch ", O'Reilly Media, 1st Edition
5. William Stallings, "Computer Organization & Architecture – Designing for performance", 11th Edition, Pearson Education Inc., 2019. (RB1).

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Embedded Software and Hardware Architecture https://www.coursera.org/learn/embedded-software-hardware
2. Embedded System Design with ARM By Prof. Indranil Sengupta, Prof. Kamalika Dutta | IIT Kharagpur (NPTEL) https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. The 8085 Microcontroller and Embedded Systems by M. Mazidi (Ebook) http://irist.iust.ac.ir/files/ee/pages/az/mazidi.pdf
4. https://presiuniv.knimbus.com/user#/home

5. NPTEL Course on "Computer architecture and organization" IIT Kharagpur By Prof. Indranil Sengupta, Prof. Kamalika Datta. https://nptel.ac.in/courses/106105163
6. W2. NPTEL Course on "Computer Organization", IIT Madras By Prof. S. Raman. https://nptel.ac.in/courses/106106092

E-content:

1. M. Unger, G. Fries, T. Steinecke, C. Waghmare and R. Ramaswamy, "Functional Safety Test Strategy for Automotive Microcontrollers During Electro-Magnetic Compatibility Characterization," 2019 12th International Workshop on the Electromagnetic Compatibility of Integrated Circuits (EMC Compo), 2019, pp. 49-51, https://ieeexplore.ieee.org/document/8919673
2. J. Yater et al., "Highly Optimized Nanocrystal-Based Split Gate Flash for High Performance and Low Power Microcontroller Applications," 2011 3rd IEEE International Memory Workshop (IMW), 2011, pp. 1-4 https://ieeexplore.ieee.org/document/5873213
3. C. Kuo et al., "A microcontroller with 100 K bytes embedded flash EEPROM," Proceedings of 4th International Conference on Solid-State and IC Technology, 1995, pp. 138-140 https://ieeexplore.ieee.org/document/499653

A. Wild et al., "A 0.9V Microcontroller for Portable Applications," ESSCIRC '96: Proceedings of the 22nd European Solid-State Circuits Conference, 1996, pp. 264-267. https://ieeexplore.ieee.org/document/5468642

Topics relevant to development of "FOUNDATION SKILLS": Assembly Language Programming using instruction set of 8051 for basic ALP programming and also Interfacing of Peripheral devices with a microcontroller.
Topics relevant to development of "EMPLOYABILITY": Embedded C programming and Interfacing.
Topics relevant to "ENTREPRENEURSHIP": Building programming skills using Assembly instructions/C code which can be extended to build modern control systems in electronics domain. Example – car cruise control, antilock brake system, Traffic controlling etc.

Catalogue prepared by	Dr. Mohammed Aarif K.O.
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3044	**Course Title: IC Fabrication Technology** **Type of Course: Discipline Elective & Theory only** **Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	VLSI Design, design and implementation of VLSI circuits for complex digital and analog systems, NMOS and CMOS fabrication steps, design for testability and design verification.						
Anti-requisites	NIL						
Course Description	The purpose of this course is to enable the students to understand the basics of IC fabrication technology. This course aims to foster knowledge of Integrated circuit technology and fabrication techniques. This course introduces the various manufacturing methods and their underlying scientific principles in the context of technologies used in VLSI chip fabrication and Microcontrollers. This course also discusses the complexities and challenges associated with VLSI chip fabrication and different Microcontrollers. The course gives clear understanding about entire Chip fabrication.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of IC Fabrication Technology and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: 1) Describe the process involved in semiconductor crystal growth and fabrication. 2) Classify various lithography and etching techniques used for pattern transfer. 3) Summarize the diffusion and ion implantation mechanisms in IC fabrication. 4) Discuss the process involved in packaging and yield.						
Course Content:							
Module 1	**Crystal Growth**	Quiz	Memory Recall based Quizzes				**12 Session**
Topics: Introduction, electronic-grade silicon, czochralski crystal growing-crystal structure, crystal growing theory, crystal growing practise, shaping operations, etching, process considerations.							
Module 2	**Oxidation and lithography**	Assignment	Theoretical Understanding				**12 Session**
Topics: Growth mechanics and kinetics, thin oxides, oxidation techniques and systems, optical lithography-optical resists, electron lithography-resists, mask generation, X-ray lithography-resists, ion lithography							
Module 3	**Diffusion and Implantation**	Assignment	Theoretical Understanding				**14 Session**
Topics: Models of diffusion in solids, one dimensional diffusion equations, atomic diffusion mechanisms, measurement techniques, Ion implantation-range theory-ion stopping, range distribution, Furnace Annealing, high energy implantation, Metallization applications, choices, physical vapour deposition, metallization problems, introduction to packaging, package types,							

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Application Area – Facility Manager, Process Engineer , Process development designer , Facility Engineer, Process simulation Engineer**.**

Professionally Used Software: ATHENA/SILVACO , SYNOPSIS , TCAD , VISUAL TCAD

Text Book

1. S.M. Sze, "VLSI technology", Tata McGraw Hill, Second Edition, 2017.

Reference(s):

Reference Books

1. S. K. Ghandhi, "VLSI Fabrication Principles: Silicon and Gallium Arsenide", John Wiley and Sons Inc., New York , 1983.
2. Plummer J. D., Deal M. D. and P. B. Griffin , "Silicon VLSI Technology: Fundamentals, Practice and Modeling" , Pearson/PHI, 2001.
3. Plummer J. D., Deal M. D. and P. B. Griffin , "Silicon VLSI Technology: Fundamentals, Practice and Modeling" , Pearson/PHI, 2001.
4. James Plummer, M. Deal and P.Griffin, "Silicon VLSI Technology", Prentice Hall, Electronics and vLSI series, 2000.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview
2. Udemy - https://www.udemy.com/course/pcb-design-and-fabrication-for-everyone/
3. Coursera - https://www.coursera.org/lecture/leds-semiconductor-lasers/introduction-to-semiconductor-fundamentals-3zejs
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. William Cheng-Yu Ma;Yan-Jia Huang;Po-Jen Chen;Jhe-Wei Jhu;Yan-Shiuan Chang;Ting-Hsuan Chang ,"Impacts of Vertically Stacked Monolithic 3D-IC Process on Characteristics of Underlying Thin-Film Transistor" , IEEE Journal of the Electron Devices Society 2020 , https://ieeexplore.ieee.org/document/9141258
2. NEGIN ZARAEE 1 , BOYOU ZHOU 1 , KYLE VIGIL 2 , MOHAMMAD M. SHAHJAMALI 3 , AJAY JOSHI 1 , AND M. SELIM ÜNLÜ , "Gate-Level Validation of Integrated Circuits With Structured-Illumination Read-Out of Embedded Optical Signatures" , IEEE,2020, https://ieeexplore.ieee.org/document/9063443
3. IN-GON LEE1 , WON-SEOK OH2 , YOON JAE KIM2 , AND IC-PYO HONG , "Design and Fabrication of Absorptive/ Transmissive Radome Based on Lumped Elements Composed of Hybrid Composite Materials" , IEEE Access 2020 , https://ieeexplore.ieee.org/document/9141287

Topics relevant to "SKILL DEVELOPMENT": Growth mechanics and kinetics, oxidation techniques and systems, packaging design considerations -for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3173	**Course Title: Introduction to CMOS VLSI Design** **Type of Course: Program Core Theory**		**L- T- P- C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.						
Anti-requisites	**NIL**						
Course Description	This course provides insights into the fundamentals of VLSI Design-based systems. The course develops the knowledge of both hardware and software that leads to the design and implementation of both analogue VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of analog circuit design and layout using cadence virtuoso.						
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using PARTICIPATIVE LEARNING techniques.						
Course Outcomes	CO1 Discuss the basic concepts of VLSI design. Understand CO2 Interpret the MOS transistor theory. Understand CO3 Evaluate the working of various CMOS Sub-circuits and Single Stage Amplifier. Understand CO4 Design the CMOS Amplifier Apply CO5 Analyze the different issues in layout, and floor Testing. Apply						
Course Content:							
Module 1	**Basic MOS Device Physics**	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions			
MOSFET Structure and Symbols, MOS I/V Characteristics, Second-Order Effects, MOS Device Models: MOS Device Layout, MOS Device Capacitances, MOS Small-Signal Model, MOS SPICE models, NMOS Versus PMOS Devices, Long-Channel Versus Short-Channel Devices MOS Inverters-Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with N-type MOSFET Load. Introduction SiGe BICMOS Technology.							
Module 2	**CMOS Sub-Circuits and Single-Stage Amplifiers**	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions			
Revision of stick diagram, layout. large signal analysis of MOS Devices. MOS Switch, MOS Diode/Active Resistor, Current Sinks and Sources, Current Mirrors Current and Voltage References Single-Stage Amplifiers: Common Source, Common Drain and Common Drain Amplifier.							
Module 3	CMOS Amplifiers	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions			
Cascode Amplifier and Folder Cascode Amplifier, Design of Differential amplifier: large and Small Signal model, Slew Rate and OPAMP: Ideal vs Practical, Compensation of Opamp,							

Design of Single and 2 Stage opamp.				
Module 4		Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions
Basics of data converters; Analog Testing, Floor Planning and Layout issues; Low Voltage and Low Power Circuits; Introduction to RF Electronics, Introduction to current mode VLSI design.				

Targeted Application & Tools that can be used:

Targeted Applications: Design of different VLSI Circuits and Subcircuits for industrial applications

Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

1. **Find the aspect ratio of the Differential Amplifier for the given gain, slew rate and bandwith and hence design and verify the differential amplifier in cadence virtuoso.**
2. **Find the aspect ratio of the 2stage OPAMP for the given gain, slew rate and bandwith and hence design and verify the differential amplifier in cadence virtuoso.**
3. **Design the CMOS-based rectifier circuits in cadence virtuoso to obtain the constant output of 2 V, if the peak input ac voltage is 3 V at the frequency of 300 Hz and internal resistance is 2Mohm and Internal capacitance is 10 nF.**

Text Books:

1. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001
2. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997

Reference(s):

Reference Books

1. B. Razavi, RF Microelectronics, Prentice-Hall, 1998.
2. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997.
3. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
4. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. 1. Video lectures on "VLSI Devices: Modeling and Simulation" by Prof. Dr. S K Lahiri, IIT KGP
http://www.satishkashyap.com/2013/07/video-lectures-on-vlsi-devices-modeling.html.
2. VLSI Design, IIT Bombay by Prof. A.N. Chandorkarhttps://nptel.ac.in/courses/117/101/117101058/
3. CMOS Digital VLSI Design by Prof. SudebDasgupta, IIT Roorkee. https://onlinecourses.nptel.ac.in/noc21_ee09/preview

E-content:

1. Konar, Maitraiyee, Rashmi Sahu, and Sudip Kundu. "Improvement of the gain accuracy of the instrumentation amplifier using a very high gain operational amplifier." In *2019 Devices for Integrated Circuit (DevIC)*, pp. 408-412. IEEE, 2019. https://ieeexplore.ieee.org/abstract/document/8783414
2. Kundu, Sudip, and Pradip Mandal. "ISGP: Iterative sequential geometric programming for precise and robust CMOS analog circuit sizing." *Integration* 47, no. 4 (2014): 510-531. https://www.sciencedirect.com/science/article/pii/S0167926014000078
3. Singh, Geetanjali, Srikanta Pal, and Sudip Kundu. "A zero bias highly efficient active diode circuit for piezoelectric energy harvester." *International Journal of*

Nanoparticles 14, no. 2-4 (2022): 106-120. https://www.inderscienceonline.com/doi/abs/10.1504/IJNP.2022.126377
4. Kundu, Sudip, and Pradip Mandal. "A generic and efficient modeling of phase margin of high performance CMOS OpAmps." In *Proceedings of the 2014 IEEE Students' Technology Symposium*, pp. 164-169. IEEE, 2014. https://ieeexplore.ieee.org/abstract/document/6808040
5. Kumar, Vikash, Rishab Mehra, and Aminul Islam. "A 2.5 GHz Low Power, High-${Q} $, Reliable Design of Active Bandpass Filter." *IEEE Transactions on Device and Materials Reliability* 17, no. 1 (2017): 229-244. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7814293

5.Presidency University Library Link:-https://presiuniv.knimbus.com/user#/home

Topics related to the development of "FOUNDATION SKILLS": MOS Transistors,
Topics related to the development of "EMPLOYABILITY": Design of Opamp

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3174	**Course Title: Introduction to CMOS VLSI Design Lab** **Type of Course: Program Core Lab**	**L- T- P- C**	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.					
Anti-requisites	**NIL**					
Course Description	This course provides insights into the fundamentals of VLSI Design-based systems. The course develops the knowledge of both hardware and software that leads to the design and implementation of both analogue VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of analog circuit design and layout using cadence virtuoso.					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	CO1 Analyse the MOS Transistor parameter. Analyse CO2 Analyse the designed Gates in Cadence Virtuoso. Analyse CO3 Create the schematic and symbol of CMOS amplifier. Analyse CO4 Analyze the different issues in layout, and floor Testing. Analyse					
Course Content:						

List of Laboratory Tasks:

Lab 0: Familiarisation of the Cadence Lab.
Lab experiments:

1. Design a MOS transistor (nmos and pmos) using the cadence tool and obtain its Static Characteristics. Find the relationship between Current ID (Drain current) and Voltage VDS (Drain to Source voltage) for different values of Vgs (Gate to Source voltages). Find ID, Vgs and VDS? In which region the transistor is operating?
2. Design and simulate the Invertor Circuits, Create Symbol and Layout of the Invertor (All 3 Compulsory)
3. Design and Simulate the NAND gate, Create Symbol and layout of Nand gate. (All 3 Compulsory)
4. Design and simulate the NOR gate, Create Symbol and layout of NOR gate (All 3 are Compulsory)
5. Design the common source amplifier with given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design.
6. Design the common drain amplifier with the given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design.
7. Design the single stage CMOS differential amplifier with the given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout

and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design

8. Design an op-amp with given specification* using given differential amplifier & Common source amplifier in library** and completing the design flow mentioned below. (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design
9. Design a 4 bit R-2R based DAC for the given specification and completing the design flow mentioned using given op-amp in the library**.(a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design

(Optional Experiments)

Targeted Application & Tools that can be used:

Targeted Applications: Design of different VLSI Circuits and Subcircuits for industrial applications

Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

4. **Find the aspect ratio of the Differential Amplifier for the given gain, slew rate and bandwith and hence design and verify the differential amplifier in cadence virtuoso.**
5. **Find the aspect ratio of the 2stage OPAMP for the given gain, slew rate and bandwith and hence design and verify the differential amplifier in cadence virtuoso.**
6. **Design the CMOS-based rectifier circuits in cadence virtuoso to obtain the constant output of 2 V, if the peak input ac voltage is 3 V at the frequency of 300 Hz and internal resistance is 2Mohm and Internal capacitance is 10 nF.**

Text Books:

3. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001
4. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997

Reference(s):

Reference Books

5. B. Razavi, RF Microelectronics, Prentice-Hall, 1998.
6. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997.
7. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
8. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. 1. Video lectures on "VLSI Devices: Modeling and Simulation" by Prof. Dr. S K Lahiri, IIT KGP http://www.satishkashyap.com/2013/07/video-lectures-on-vlsi-devices-modeling.html.
2. VLSI Design, IIT Bombay by Prof. A.N. Chandorkarhttps://nptel.ac.in/courses/117/101/117101058/
3. CMOS Digital VLSI Design by Prof. SudebDasgupta, IIT Roorkee. https://onlinecourses.nptel.ac.in/noc21_ee09/preview

E-content:

6. Konar, Maitraiyee, Rashmi Sahu, and Sudip Kundu. "Improvement of the gain accuracy

of the instrumentation amplifier using a very high gain operational amplifier." In *2019 Devices for Integrated Circuit (DevIC)*, pp. 408-412. IEEE, 2019. https://ieeexplore.ieee.org/abstract/document/8783414
7. Kundu, Sudip, and Pradip Mandal. "ISGP: Iterative sequential geometric programming for precise and robust CMOS analog circuit sizing." *Integration* 47, no. 4 (2014): 510-531. https://www.sciencedirect.com/science/article/pii/S0167926014000078
8. Singh, Geetanjali, Srikanta Pal, and Sudip Kundu. "A zero bias highly efficient active diode circuit for piezoelectric energy harvester." *International Journal of Nanoparticles* 14, no. 2-4 (2022): 106-120. https://www.inderscienceonline.com/doi/abs/10.1504/IJNP.2022.126377
9. Kundu, Sudip, and Pradip Mandal. "A generic and efficient modeling of phase margin of high performance CMOS OpAmps." In *Proceedings of the 2014 IEEE Students' Technology Symposium*, pp. 164-169. IEEE, 2014. https://ieeexplore.ieee.org/abstract/document/6808040
10. Kumar, Vikash, Rishab Mehra, and Aminul Islam. "A 2.5 GHz Low Power, High-${Q} $, Reliable Design of Active Bandpass Filter." *IEEE Transactions on Device and Materials Reliability* 17, no. 1 (2017): 229-244. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7814293

5.Presidency University Library Link:-https://presiuniv.knimbus.com/user#/home

Topics related to the development of "FOUNDATION SKILLS": MOS Transistors,
Topics related to the development of "EMPLOYABILITY": Design of Opamp

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3177**	**Course Title: RF Integrated Circuits and Systems** **Type of Course: Program Core (Theory)**		**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic knowledge of Electromagnetic Theory Analog and Digital Communication Systems Fundamentals of Microelectronics and VLSI Basic understanding of Network Analysis and Semiconductor Devices					
Anti-requisites	NIL					
Course Description	This course explores RF Integrated Circuits (RFICs) and Systems, covering RF transceiver architectures, impedance matching, noise analysis, RF amplifier design, mixers, oscillators, and PLLs. The course includes hands-on lab experiments using Cadence Virtuoso with UMC PDK, focusing on RF design, simulation, layout, and parasitic extraction.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Communication Engineering and attain the SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1] Explain RF transceiver design principles and circuit components. 2] Analyze and simulate RF amplifiers, mixers, and oscillators. 3] Apply impedance matching and noise analysis techniques to RF circuits. 4] Perform Cadence-based RF circuit design, layout, and post-layout validation. 5] Integrate RFIC designs into wireless communication systems.					
Course Content:						
Module 1	Fundamentals of RF Circuits and Systems	Assignment	Simulation task: S-parameter simulation of passive networks using Cadence	**12classes**		
Topics: Introduction to RFICs and RF Transceivers, RF circuit characteristics: High-frequency effects, transmission lines, Impedance Matching Techniques: L-section, T-section, and Smith Chart usage, Noise in RF Circuits: Noise Figure, Phase Noise, Sensitivity, and Linearity, RF system architectures: Superheterodyne vs. Direct Conversion Receivers						
Module 2	RF Amplifiers and Mixers	Case Study	Simulation task: Gilbert Cell Mixer design using UMC PDK	**12 classes**		
Topics: Low Noise Amplifiers (LNA): Topologies, Noise Performance, Gain Analysis, Power Amplifiers (PA): Class A, B, AB, C, D, E, and F amplifiers, Linearity and Efficiency considerations						

in RF Pas, Mixers: Basic principles, Non-linearity, Image Rejection, Conversion Gain, Heterodyne vs. Homodyne Mixers, Gilbert Cell Mixer Design				
Module 3	Oscillators and Frequency Synthesizers	Assignment	Simulation task: Design and Simulation of an RF Oscillator	**12 classes**
RF Oscillators: LC Oscillators, Colpitts, Hartley, Clapp, and Cross-coupled oscillators, Phase Locked Loops (PLL): Basics, Locking Range, Capture Range, Jitter, Frequency synthesizers: Integer-N and Fractional-N Synthesizers, Voltage-Controlled Oscillators (VCOs) and Noise considerations				
Module 4	RF System Integration and Applications	Assignment	Simulation task: RF System Design for a Wireless Communication Link	**12 classes**
Topics: RFIC technologies: CMOS, SiGe, GaAs RF ICs, Transceiver design for Wi-Fi, 5G, and IoT applications Antenna integration and Impacts on RFICs, RFIC Testing: S-parameters, Modulation Techniques, and BER Analysis, Overview of MEMS-based RF Devices and Future Trends				

Text Book(s):

1. Lee, T. H. (2003). *The design of CMOS radio-frequency integrated circuits*. Cambridge university press.
2. Razavi, B. (2011). RF microelectronics second edition. *2011: Pearson Education, Inc.*
3. Pozar, D. M. (2021). *Microwave engineering: theory and techniques*. John wiley & sons.

Reference(s):

Reference Book(s):

1. Bowick, C. (2011). *RF circuit design*. Elsevier.
2. Ludwig, R. (2000). *RF Circuit Design: Theory & Applications, 2/e*. Pearson Education India.
3. Razavi, B., & Behzad, R. (2012). *RF microelectronics* (Vol. 2, pp. 255-333). New York: Prentice hall.
4. Egan, W. F. (2004). *Practical RF system design*. John Wiley & Sons.

Online Resources (e-books, notes, ppts, video lectures etc.):

6. NPTEL COURSE: https://archive.nptel.ac.in/courses/117/102/117102012/
7. Video Lectures:

https://www.youtube.com/watch?v=KUDGGsyh1Hs&list=PLbMVogVj5nJQdGDSx243YPnNeLMBrhNE8

8. Video Lectures:

https://www.youtube.com/watch?v=l9K1Ps0eBAc&list=PLq9LyOMVV3rSHxPjGwO5PfwoLowBbZ62l

9. Presidency Library Link:-https://presiuniv.knimbus.com/user#/home

E-content:

5. Heydari, P. (2021). Terahertz integrated circuits and systems for high-speed wireless communications: Challenges and design perspectives. *IEEE Open Journal of the Solid-State Circuits Society*, *1*, 18-36.

DOI: 10.1109/OJSSCS.2021.3110748

6. Seo, H., & Zhou, J. (2021). A passive-mixer-first acoustic-filtering superheterodyne RF front-end. *IEEE Journal of Solid-State Circuits*, *56*(5), 1438-1453.

https://ieeexplore.ieee.org/abstract/document/9391989

7. Ruffino, A., Peng, Y., Yang, T. Y., Michniewicz, J., Gonzalez-Zalba, M. F., & Charbon, E. (2021, February). 13.2 A fully-integrated 40-nm 5-6.5 GHz cryo-CMOS system-on-chip with I/Q receiver and frequency synthesizer for scalable multiplexed readout of quantum dots. In *2021 IEEE International Solid-State Circuits Conference (ISSCC)* (Vol. 64, pp. 210-212). IEEE.

https://ieeexplore.ieee.org/abstract/document/9365758

8. De, A., Roy, B., & Bhattacharjee, A. K. (2021). Miniaturized dual band consumer transceiver antenna for 5G-enabled IoT-based home applications. *International Journal of Communication Systems*, *34*(11), e4840.

https://doi.org/10.1002/dac.4840

Topics relevant to “SKILL DEVELOPMENT”: Sampling, TDM, PCM, DPCM, DM, Digital Modulation, Spread Spectrum for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Prabhu T
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th, Dated 03/08/2024

Course Code: **ECE3178**	**Course Title: RF Integrated Circuits and Systems Lab** **Type of Course: Professional Core (Lab)**	**L-T-P-C**	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Basic knowledge of Electromagnetic Theory Analog and Digital Communication Systems Fundamentals of Microelectronics and VLSI Basic understanding of Network Analysis and Semiconductor Devices					
Anti-requisites	NIL					
Course Description	This lab focuses on designing, simulating, and analyzing RF Integrated Circuits (RFICs) using Cadence Virtuoso with UMC PDK and MATLAB/SIMULINK. It covers RF components such as Low-Noise Amplifiers (LNAs), Mixers, Voltage-Controlled Oscillators (VCOs), Phase-Locked Loops (PLLs), and RF Power Amplifiers. Students will perform both circuit-level and system-level simulations, layout designs, post-layout validation, and study RF transceiver integration. The laboratory experiments integrated with the theory provide an opportunity for the students to validate the concepts learned in theory through experiments and motivate the students to extend such laboratory experiments to real life applications.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of RF Integrated Circuits and Systems and attain the SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1] Design, simulate, and validate RFIC components such as LNAs, Mixers, and VCOs using Cadence Virtuoso with UMC PDK. 2] Implement AM, demodulation, RF filtering, and transceiver simulations using MATLAB/SIMULINK for system-level analysis.					
Course Content:						

List of Laboratory Tasks:

Experiment N0 1: Introduction to RFIC Design and Cadence Virtuoso Setup

Level1:

Set up UMC PDK in Cadence Virtuoso

Perform DC/AC analysis of RF devices (MOSFETs, BJTs)

Study S-parameters and Noise Figure simulation

Level2:

MATLAB simulation of RF circuit response

Evaluate the effect of frequency variations on circuit parameters

Experiment N0 2: Implementation of Amplitude Modulation (AM) and Demodulation

Level1:

Design an AM circuit in Cadence Virtuoso

Study modulation index and carrier signal effects

Level2:

Implement AM using MATLAB/SIMULINK

Analyze signal behaviour with different modulation depths

Experiment N0 3: Impedance Matching and S-Parameter Analysis

Level1:

Design an L-section and T-section impedance matching network

Perform Smith Chart-based matching simulations

Level2:

MATLAB simulation of impedance transformation for different loads

Experiment N0 4: Design and Simulation of a Low Noise Amplifier (LNA)

Level1:

Design a CMOS LNA using UMC PDK (180nm/65nm)

Analyze Gain, Noise Figure, and Linearity

Level2:

MATLAB/SIMULINK simulation of LNA gain vs. noise figure trade-off.

Experiment N0 5: Mixer Design and Performance Analysis

Level1:

Design a Gilbert Cell Mixer using UMC RF PDK MOSFETs

Simulate Conversion Gain and Noise Figure.

Level2:

MATLAB-based mixer frequency response and distortion analysis.

Experiment N0 6: Voltage-Controlled Oscillator (VCO) Design and Phase Noise Analysis

Level1:

Design an LC-VCO using UMC RF PDK Inductors

Perform Phase Noise Simulation in SpectreRF

Level2:

MATLAB simulation of oscillator tuning range and phase noise.

Experiment N0 7: Phase-Locked Loop (PLL) Simulation and Analysis

Level1:

Design a basic Integer-N PLL in Cadence Virtuoso

Analyze Lock Time, Jitter, and Phase Noise

Level2:

MATLAB-based PLL modeling and transient response analysis

Experiment N0 8: RF Power Amplifier (PA) Design and Load-Pull Analysis

Level1:

Design a Class A/B Power Amplifier using UMC RF MOSFETs

Simulate Efficiency and Linearity Performance

Level2:

MATLAB simulation of power amplifier output spectrum and efficiency trade-offs

Experiment No. 9: RFIC Transceiver System Design and Integration

Level1:

Integrate LNA, Mixer, and LO Chain into an RF Transceiver

Perform Monte Carlo Analysis for process variations

Level2:

MATLAB-based end-to-end RF transceiver system simulation

Experiment No. 10: Post-Layout Validation and Parasitic Extraction (PEX)

Level1:

Perform LVS, DRC, and PEX on an RFIC block

Analyze post-layout parasitics and their effects

Level2:

MATLAB simulation of high-frequency parasitic effects on circuit performance

Text Book(s):

1. Lee, T. H. (2003). *The design of CMOS radio-frequency integrated circuits*. Cambridge university press.
2. Razavi, B. (2011). RF microelectronics second edition. *2011: Pearson Education, Inc.*
3. Pozar, D. M. (2021). *Microwave engineering: theory and techniques*. John wiley & sons.

Reference(s):

Reference Book(s):

1. Bowick, C. (2011). *RF circuit design*. Elsevier.
2. Ludwig, R. (2000). *RF Circuit Design: Theory & Applications, 2/e*. Pearson Education India.
3. Razavi, B., & Behzad, R. (2012). *RF microelectronics* (Vol. 2, pp. 255-333). New York: Prentice hall.
4. Egan, W. F. (2004). *Practical RF system design*. John Wiley & Sons.

Online Resources (e-books, notes, ppts, video lectures etc.):

10. NPTEL COURSE: https://archive.nptel.ac.in/courses/117/102/117102012/
11. Video Lectures:

https://www.youtube.com/watch?v=KUDGGsyh1Hs&list=PLbMVogVj5nJQdGDSx243YPnNeLMBrhNE8

12. Video Lectures:

https://www.youtube.com/watch?v=l9K1Ps0eBAc&list=PLq9LyOMVV3rSHxPjGwO5PfwoLowBbZ62l

13. Presidency Library Link:-https://presiuniv.knimbus.com/user#/home

E-content:

9. Heydari, P. (2021). Terahertz integrated circuits and systems for high-speed wireless communications: Challenges and design perspectives. *IEEE Open Journal of the Solid-State Circuits Society*, *1*, 18-36.

DOI: 10.1109/OJSSCS.2021.3110748

10. Seo, H., & Zhou, J. (2021). A passive-mixer-first acoustic-filtering superheterodyne RF front-end. *IEEE Journal of Solid-State Circuits*, *56*(5), 1438-1453.

https://ieeexplore.ieee.org/abstract/document/9391989

11. Ruffino, A., Peng, Y., Yang, T. Y., Michniewicz, J., Gonzalez-Zalba, M. F., & Charbon, E. (2021, February). 13.2 A fully-integrated 40-nm 5-6.5 GHz cryo-CMOS system-on-chip with I/Q receiver and frequency synthesizer for scalable multiplexed readout of quantum dots. In *2021 IEEE International Solid-State Circuits Conference (ISSCC)* (Vol. 64, pp. 210-212). IEEE.

https://ieeexplore.ieee.org/abstract/document/9365758

12. De, A., Roy, B., & Bhattacharjee, A. K. (2021). Miniaturized dual band consumer transceiver antenna for 5G-enabled IoT-based home applications. *International Journal of Communication*

Systems, *34*(11), e4840. https://doi.org/10.1002/dac.4840	
Topics relevant to “SKILL DEVELOPMENT”: Sampling, TDM, PCM, DPCM, DM, Digital Modulation, Spread Spectrum for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Prabhu T
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE3122	**Course Title: Microelectronics** **Type of Course: Professional Core**	**L-T-P-C**	**3**	1	0	4
Version No.	1.0					
Course Pre-requisites	Basic concepts of Digital and analog circuits.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to provide students with a comprehensive understanding of the principles and applications of microelectronic devices and circuits. This course will cover the fundamental concepts and techniques necessary for the design, analysis, and fabrication of microelectronic systems.					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Understand** the fundamental principles and concepts of microelectronics. 2) **Design** basic microelectronic circuits, using industry-standard software tools for simulation and optimization. 3) **Illustrate** various fabrication processes involved in the production of microelectronic devices and integrated circuits. 4) **Apply** the microelectronics in real-world industries such as telecommunications, consumer electronics, medical devices, and automotive systems.					
Course Content:						
Module 1	**Introduction**	Quiz	Memory Recall based Quizzes			**12 session**
Topics: Solid state electronic materials, Energy band model, Drift and Diffusion Currents in Semiconductors, Mobility and Resistivity, Impurities (and doping) in Semiconductors Generation/Recombination of ElectronsHole pairs.						
Module 2	**Overview of diode (and integrated circuit)**	Assignment / Quiz	Programming task			**12 session**
Topics: The pn Junction Diode, Qualitative Description of Current Flow in Diode, Diode Equation (A mathematical model for the diode) IV Characteristics, Diode Breakdown , Diode circuits Photodiodes, Solar Cells, LEDs, Schottky diodes, Basic concepts about transistors; applications (amplifier, switch etc.) Introduction to the Bipolar Junction Transistor (BJT).						
Module 3	**Transistors**	Assignment	Memory Recall based Quizzes			**10 session**
Topics: Transport Models for npn and pnp BJTs, BJT IV Characteristics, BJT IV Characteristics, Early effect in BJT, Introduction to MOSFET. Characteristics of the MOS capacitor; NMOS Transistor IV Characteristics; MOSFET Types and Characteristics; MOSFET Types and Characteristics; The Transistor as an Amplifier.						
Module 4	**CMOS in details**	Assignment	Programming task			**09 session**
Topics:						

Digital Circuits implementation using CMOS, NMOS. Stick Diagrams. Static CMOS gates and flip-flops, transmission gates. CMOS digital building blocks: level shifters, decoders, multiplexers, tri-states, buffers. Gate timing. Memories: ROM, SRAM and DRAM cell design; sense amplifiers.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: ASICs, FPGA development, nanofabrication.

Professionally Used Software: Cadence-Virtuoso, Synopsys Design Compiler,Xilinx Vivado.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Implementation of various concepts from microelectronics.

Text Book(s):

6. Howe, R. T., and C. G. Sodini. Microelectronics: An Integrated Approach. Upper Saddle River, NJ: Prentice Hall, 1996. ISBN: 0135885183.

Reference(s):

Reference Book(s):

6. Fonstad, C. G. Microelectronic Devices and Circuits. New York, NY: McGraw-Hill, 1994. ISBN: 0070214964.
7. Sedra, A. S., and K. C. Smith. Microelectronic Circuits. 4th ed. New York, NY: Oxford University Press, 1998. ISBN: 0195116631.
8. Pierret, R. F. Semiconductor Device Fundamentals. Upper Saddle River, NJ: Prentice Hall, 1995. ISBN: 0201543931.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc21_ee86/preview
2. Online ppts :- https://lws-set.gsfc.nasa.gov/documents/Microelectronics_Summary01.pdf
3. https://presiuniv.knimbus.com/user#/home

E-content:

11. The future of microelectronics. https://ieeexplore.ieee.org/document/658769
12. Technical and economical trends in microelectronics. https://ieeexplore.ieee.org/document/4430873
13. Microelectronics-journal. https://www.sciencedirect.com/journal/microelectronics-journal

Topics related to development of "FOUNDATION": Solid state electronic materials, Energy band model

Topics related to development of "EMPLOYABILITY": CMOS digital building blocks: level shifters, decoders, multiplexers, tri-states, buffers. Gate timing. Memories: ROM, SRAM and DRAM cell design Topics related to development of "ENTREPRENEURSHIP":

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY":

Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Ethical considerations while implementing these circuits.

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3175	**Course Title: Embedded Systems** **Type of Course: Progrm Core Theory**		L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Comparison between microprocessors and microcontrollers, Instruction set of microprocessors and microcontrollers, Real world interfacing, Embedded C programming.					
Anti-requisites	**NIL**					
Course Description	**The course provides insights into the fundamentals of Embedded Systems and their design using ARM microcontrollers. This course demonstrates System design examples and case studies for real-world applications. This course also gives brief introduction of Embedded Real Time Operating System (RTOS).**					
Course Objective	**This course is designed to improve the learner's <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Describe Embedded Systems and their Interfacing to the Analogue world 2. Distinguish between various ARM architecture versions 3. Program ARM processors using Assembly and C Languages 4. Understand the concept of Real Time Operating systems					
Course Content:						
Module 1	**Fundamentals of Embedded Systems**	Quiz	Memory Recall based Quizzes	**9 sessions**		
Topics: What is an Embedded System?, Inside the Embedded System, Embedded Processors, Memory Systems, Basic Peripherals, Interfacing to the Analogue world, Interrupts and Exceptions						
Module 2	**ARM Architecture**	Quiz, Mid Term Exam	Memory Recall based Quizzes, Mid Term Exam	**12 sessions**		
Topics: Introduction to ARM® and ARM® Architecture, Cortex™-M TM4C123X processor, Comparing ARM® Cortex™-M TM4C123X processor with LPC21xx architecture, ARM and Thumb Instruction Set Overview, ARM Addressing Modes, ARM Assembly Programming						
Module 3	**ARM Programming and Interfacing**	Assignment	Programming Assignment	**12 sessions**		
Topics: Embedded C Programming– Conditional Statements, Loop Statements, debugging, single stepping, breakpoints, Concepts of Input and Output Ports, Basics of Interfacing Switches and LEDs, Interfacing Stepper Motors and DC Motors, Serial Communication, USB, RS232, CAN BUS, MOD BUS, I2C						
Module 4	**Real Time Operating Systems**	End Term Exam	End Term Exam	**12 sessions**		

	(RTOS)			

Topics:
Introduction to Embedded Real Time Operating Systems (RTOS), Types of RTOS, Architecture of Embedded RTOS, Kernel in RTOS, Overview of various systems:- MicroC/OS-II, VX Works, RTLinux, Free RTOS, Differences in operating systems.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Industry 4.0, Biomedical and Agricultural automation
Professionally Used Software: Keil Version 05/ Code Composer Studio

Project Work/Assignment:

1. Case Study: At the end of the course students will be given a 'real-world' application-based on real world embedded system case study. Students will be submitting a report which will include Application Design, sensors used, middleware protocols used and working mechanism etc. in appropriate format

2 Book/Article review: At the end of the course a literature review of any 01 recent article from the reputed national and international journal/ conferences will be given by students. They need to refer to tools like Scopus/ Google-Scholar and submit a report on their understanding of the assigned article in appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to present their review work.

Text Book(s):

7. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.
8. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition
9. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2010, 3rd Edition
10. Steve Heath, "Embedded System Design", Elsevier India, 2nd Edition.

Reference(s):
Reference Book(s):

1. Jonathan W. Valvano, "Embedded Systems: Introduction to Arm® Cortex™-M Microcontroller- Vol 01", CreateSpace Independent Publishing Platform, 1st Edition
2. Jonathan W. Valvano, "Embedded Systems: Real-Time Operating Systems for Arm® Cortex™-M Microcontrollers", CreateSpace Independent Publishing Platform, 1st Edition.
3. ARM Cortex Datasheet available on (https://www.arm.com/)
4. Raymond J.A. Buhr, Donald L.Bailey, "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall, 1st Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL online course:- https://nptel.ac.in/courses/106105036
2. University of Michigan : http://www.eecs.umich.edu/courses/eecs571/lectures/lecture1-intro.pdf
3. US-Texas online video content:- http://users.ece.utexas.edu/~gerstl/ee445m_s19/lectures.html
4. Online ppts:- https://www.cse.iitb.ac.in/~krithi/courses/684/ts-Sep-2004.pdf

E-content:

14. Joseph Sifakis, " Embedded systems design - Scientific challenges and work directions 2009 Design, Automation & Test in Europe Conference & Exhibition https://ieeexplore.ieee.org/document/5090623
15. Gabor Karsai; Fabio Massacci; Leon Osterweil; Ina Schieferdecker," Evolving Embedded Systems", Computer , VOL. 43, issue.5 https://ieeexplore.ieee.org/document/5472888
16. Sachin P. Kamat," An eye on design: Effective embedded system software", IEEE Potentials, VOL. 29, issue.5 https://ieeexplore.ieee.org/document/5568178
17. Yanbing Li; M. Potkonjak; W. Wolf, " Real-time operating systems for embedded computing", IEEE International Conference on Computer Design: VLSI in Computers and Processors, (ICCD), 12-15 Oct. 1997 https://ieeexplore.ieee.org/document/628899

Topics relevant to the: "FOUNDATION SKILLS": Classifications of Embedded Systems, Design Challenges, Metrics, Processors in Embedded Systems. RISC and CISC Architectures

Topics related to development of "EMPLOYABILITY": Interfacing Stepper Motors and DC Motors, Serial Communication, I2Cs and CANs

Topics related to development of "ENTREPRENEURSHIP": Software in Embedded Systems, Design Methodology

Catalogue prepared by	Dr. Ajit Kumar
Recommended by the Board of Studies on	19th BOS held on 3rd July 2024
Date of Approval by the Academic Council	24th Academic Council Meeting held on 03/08/2024.

Course Code: EEE3176	Course Title: Embedded systems Laboratory Type of Course: Discipline Elective (Lab)	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Comparison between microprocessors and microcontrollers, Instruction set of microprocessors and microcontrollers, Real world interfacing, Embedded C programming.					
Anti-requisites	**NIL**					
Course Description	**The course provides insights into the fundamentals of Embedded Systems and their design using ARM microcontrollers. This course demonstrates System design examples and case studies for real-world applications. This course also gives brief introduction of Embedded Real Time Operating System (RTOS).**					
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Describe Embedded Systems and their Interfacing to the Analogue world 2. Distinguish between various ARM architecture versions 3. Program ARM processors using Assembly and C Languages 4. Understand the concept of Real Time Operating systems					
Course Content:						

List of Laboratory Tasks:

Experiment No 1: Basic Arithmetic Operations

Level 1: WAP to perform addition and subtraction on two 32-bit numbers.
Level 2: WAP to calculate the average of n 32-bit numbers.

Experiment No 2: Sorting and Finding Extremes.

Level 1: WAP to sort a sequence of numbers in ascending or descending order.

Level 2: WAP to determine the largest and smallest numbers in a given sequence.

Experiment No 3: Data Transfer and Swapping.

Level 1: WAP to transfer a block of words from the source memory location to the destination.
Level 2: WAP to swap a block of words between two memory locations.

Experiment No 4: Bitwise Operations and Masking

Level 1: WAP to perform bitwise AND, OR, XOR, and NOT on 32-bit numbers.

Level 2: WAP to set, clear, and toggle specific bits in a register.

Experiment No 5: Multiplication and Division

Level 1: WAP to multiply two 16-bit numbers and store the 32-bit result.

Level 2: WAP to divide a 32-bit number by a 16-bit number and store the quotient and remainder.

Experiment No 6: String Operations

Level 1: WAP to reverse a given string stored in memory.

Level 2: WAP to compare two strings and check for equality.

Experiment No 7: Delay Generation using Timers

Level 1: WAP to generate a time delay using a software loop.

Level 2: WAP to generate a precise delay using an embedded system timer.

Experiment No 8: Interfacing LED and Switch

Level 1: WAP to toggle an LED using a switch press.

Level 2: WAP to create a binary counter using multiple LEDs.

Experiment No 9: Serial Communication (UART)

Level 1: WAP to send and receive data via UART.

Level 2: WAP to implement a simple echo program using UART.

Experiment No 10: Interrupt Handling

Level 1: WAP to generate an interrupt on a switch press.

Level 2: WAP to implement a priority-based interrupt system.

Targeted Application & Tools that can be used:

Targeted Applications: Industry 4.0, Biomedical and Agricultural automation

Professionally Used Software: Keil Version 05/ Code Composer Studio

Text Book(s):

1. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.
2. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based

Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition 3. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2010, 3rd Edition **4.** Steve Heath, "Embedded System Design", Elsevier India, 2nd Edition.	
Topics relevant to the: "FOUNDATION SKILLS": Classifications of Embedded Systems, Design Challenges, Metrics, Processors in Embedded Systems. RISC and CISC Architectures Topics related to development of "EMPLOYABILITY": Interfacing Stepper Motors and DC Motors, Serial Communication, I2Cs and CANs Topics related to development of "ENTREPRENEURSHIP": Software in Embedded Systems, Design Methodology	
Catalogue prepared by	Dr. Ajit Kumar
Recommended by the Board of Studies on	19th BOS held on 3rd July 2024
Date of Approval by the Academic Council	24th Academic Council Meeting held on 03/08/2024.

Course Code: ECE3179	**Course Title: Physical Design and Automation** **Type of Course: Program Core**		**L-T-P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.**					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.**					
Course Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using real time algorithms used in VLSI industry.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** **1. Describe various graph algorithms.** **2. Define computational complexity of different physical design algorithms.** **3. Employ various algorithms for Partitioning, Placement and Floor planning.** **4. Illustrate different types of routing algorithms.**					
Course Content:						
Module 1	**Design automation tools**	Quiz	Memory Recall based Quizzes			**10 classes**
Topics: VLSI design automation tools- algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools.						
Module 2	**Layout compaction, Placement and Partitioning**	Assignment	Design Analysis			**9 classes**
Topics: Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.						
Module 3	**Floor planning and Routing**	Assignment	Design Analysis			**9 classes**
Topics: Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.						
Module 4	**Logic**	Assignment	Programming and			**9 classes**

	Synthesis & High Level Synthesis		simulation	

Topics:
Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis. Hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

Targeted Application & Tools that can be used:
Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.
Professionally Used Software: VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project work/Assignment:

Project Assignment:

1. Develop a heuristic algorithm for finding a maximum bipartite subgraph in circle graphs.
2. Suggest modifications to the Kernighan-Lin algorithm to speed up the algorithm.
3. Design an efficient heuristic algorithm based on maze routing to simultaneously route two 2-terminal nets on a grid graph. Compare the routing produced by this algorithm with that produced by Lee's maze router by routing one net at a time.
4. Implement the approximation algorithm for finding a *k*-independent set in circle graphs. Experimentally evaluate the performance of the algorithm by implementing an exponential time complexity algorithm for finding a *k*-independent set.

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

1. **S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.**
2. **M. L. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI circuits", Kluwer, 2001.**

Reference(s):

1. **Stephen Trimberger, "Introduction to CAD for VLSI", Kluwer Academic publisher, 2002.**
2. **Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, 2nd edition.**
3. **G. Hachtel and F. Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer, 1998. 3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers; 3rd ed., 1999.**

Online and Web resource (s):

1. **https://nptel.ac.in/courses/106/106/106106088/**
2. **https://cse.ucsd.edu/faculty-research/vlsicad-computer-aided-design**
3. **http://www.facweb.iitkgp.ac.in/~isg/CAD/**
4. **https://www.youtube.com/watch?v=hJTK5nj1iq8**
5. **https://www.youtube.com/watch?v=WLdbujc-aH4**
6. **https://www.youtube.com/watch?v=zkFRfmySFOw**

E-Content:

1. H. Martin Bucker and Christian Sohr Bucker "Reformulating a Breadth-First Search

Algorithm on an Undirected Graph in the Language of Linear Algebra" in IEEE 2014 International Conference on Mathematics and Computers in Sciences and in Industry, 33–35. doi:10.1109/MCSI.2014.40
https://ieeexplore.ieee.org/abstract/document/7046157

2. Farnaz Towhidi, Arash Habibi Lashkari "Binary Decision Diagram (BDD)" in IEEE 2009 International conference on future computer and communication, 03-05 April 2009, doi:10.1109/ICFCC.2009.31 https://ieeexplore.ieee.org/abstract/document/5189833.
3. Archana K Rajan, Deepika Bhaiya "VLSI partitioning using parallel kernighan lin algorithm" in IEEE 2017 International Conference on Communication and Signal Processing (ICCSP)-CHENNAI, India (2017.4.6-2017.4.8)doi:10.1109/ICCSP.2017.8286727 https://ieeexplore.ieee.org/abstract/document/8286727.
4. Groeneveld R "Physical design challenges for billion transistor chips" in IEEE International Conference on Computer Design-Freiberg, Germany(16-18 Sept. 2002), 78–83. doi:10.1109/ICCD.2002.1106751. https://ieeexplore.ieee.org/abstract/document/1106751.

Topics Relevant to development of "FOUNDATION SKILLS": Design Methodologies, Algorithmic Graph Theory, Tractable and Intractable Problems.

Topics Relevant to development of "EMPLOYABILITY": Layout compaction, Placement and Partitioning, floor planning, Routing.

Catalogue prepared by	Dr. JOSEPH ANTHONY PRATHAP, Associate Professor, ECE, Presidency University.
Recommended by the Board of Studies on	19th BOS held on 3rd July 2024
Date of Approval by the Academic Council	24th Academic Council Meeting held on 03/08/2024.

Course Code: ECE3180	**Course Title:** Physical Design and Automation Laboratory **Type of Course:** Program Core Theory Only	**L-T- P-C**	0	0	2	4
Version No.	2.0					
Course Pre-requisites	**Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.**					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.**					
Course Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using real time algorithms used in VLSI industry.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** **5. Describe various graph algorithms.** **6. Define computational complexity of different physical design algorithms.** **7. Employ various algorithms for Partitioning, Placement and Floor planning.** **8. Illustrate different types of routing algorithms.**					
Course Content:						

List of Laboratory Tasks:

Experiment No. 1: Study of Resistors, Measuring instruments and DC Power Supply.
Level 1: Identification of resistor values from color bands and verification with Multimeter.
Level 2: Connecting a resistive circuit to a DC Power Supply and observing the input and output values using Voltmeters, Ammeters and hence calculate resistance values.

Experiment No. 2: Study of Reactive components, Multimeter, CRO and Function Generator.
Level 1: Identification of various types of capacitive and inductive components and verification with Multimeter.
Level 2: Connecting a reactive circuit to a function generator and observing the input and output waveform on CRO and calculation of Reactance and Impedance.

Experiment No. 3: Study of PN-Junction Diode Characteristics in Forward and Reverse Bias Conditions.
Level 1: Carry out the experiment to find cut-in voltage on forward characteristics for Silicon P-N Junction diode.
Level 2: Carry out experiment to plot VI Characteristics of Silicon P-N Junction Diode in both forward and reverse biased conditions for Si P-N Junction diode.

Experiment No. 4: To observe the output waveform of half wave and full wave rectifier circuit and compute ripple factor and efficiency

Level 1:
Identify the components required for a rectifier circuit, rig up the circuit, and sketch the output waveforms without filter.
Level 2:
Rig up the rectifier circuit with RC filter, observe the output waveforms, determine the efficiency and ripple factor.

Experiment 5: To construct clipping and clamping circuits for different reference voltages and to verify the responses.
Level 1:
Identify the components required for building a Clipper / Clamper circuit. Rig up the circuit according to the circuit diagram given and sketch the output waveform.
Level 2:
Given a sinusoidal input of 10 V p-p, implement a positive / negative clipper with output clipped at 2 V.

Experiment No. 6: Study of Bipolar Junction Transistor in different regions of operation.
Level 1: Carry out the experiment to understand the importance of active, cut off and saturation regions.
Level 2: Carry out the experiment to design and analyze the operation of transistor as switch.

Experiment 7: To calculate various parameters of emitter follower circuit using BJT
Level 1:
Identify the components required to implement an emitter follower circuit. Rig up the circuit and observe the variations in output waveform with respect to the variations in input waveform.
Level 2:
Determine the values of Zin input impedance and Zout output impedance for Emitter Follower.

Experiment 8: To sketch input and output characteristics of a transistor and to calculate input/ output resistance and current gain using h-parameters
Level 1:
Setup an experiment to sketch the input and output characteristics of a transistor (BJT).
Level 2:
From the input and output characteristics obtained determine parameters such as input resistance, output resistance and gain of the transistor.

Experiment 9: To Implement RC Coupled amplifier using a BJT and sketch the frequency response.
Level 1: Identify the components required to implement an RC coupled amplifier circuit. Rig up the circuit and sketch the frequency response.
Level 2: From the frequency response curve determine the value of the mid band gain and the bandwidth.

Targeted Application & Tools that can be used:
Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.
Professionally Used Software: VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project work/Assignment:

Project Assignment:

5. Develop a heuristic algorithm for finding a maximum bipartite subgraph in circle graphs.
6. Suggest modifications to the Kernighan-Lin algorithm to speed up the algorithm.
7. Design an efficient heuristic algorithm based on maze routing to simultaneously route two 2-terminal nets on a grid graph. Compare the routing produced by this algorithm with that produced by Lee's maze router by routing one net at a time.
8. Implement the approximation algorithm for finding a *k*-independent set in circle graphs. Experimentally evaluate the performance of the algorithm by implementing an exponential time complexity algorithm for finding a *k*-independent set.

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

3. **S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.**
4. **M. L. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI circuits", Kluwer, 2001.**

Reference(s):

4. **Stephen Trimberger, "Introduction to CAD for VLSI", Kluwer Academic publisher, 2002.**
5. **Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, 2nd edition.**
6. **G. Hachtel and F. Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer, 1998. 3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers; 3rd ed., 1999.**

Online and Web resource (s):

7. **https://nptel.ac.in/courses/106/106/106106088/**
8. **https://cse.ucsd.edu/faculty-research/vlsicad-computer-aided-design**
9. **http://www.facweb.iitkgp.ac.in/~isg/CAD/**
10. **https://www.youtube.com/watch?v=hJTK5nj1iq8**
11. **https://www.youtube.com/watch?v=WLdbujc-aH4**
12. **https://www.youtube.com/watch?v=zkFRfmySFOw**

E-Content:

5. H. Martin Bucker and Christian Sohr Bucker "Reformulating a Breadth-First Search Algorithm on an Undirected Graph in the Language of Linear Algebra" in IEEE 2014 International Conference on Mathematics and Computers in Sciences and in Industry, 33–35. doi:10.1109/MCSI.2014.40 **https://ieeexplore.ieee.org/abstract/document/7046157**
6. Farnaz Towhidi, Arash Habibi Lashkari "Binary Decision Diagram (BDD)" in IEEE 2009 International conference on future computer and communication, 03-05 April 2009, doi:10.1109/ICFCC.2009.31 https://ieeexplore.ieee.org/abstract/document/5189833.
7. Archana K Rajan, Deepika Bhaiya "VLSI partitioning using parallel kernighan lin algorithm" in IEEE 2017 International Conference on Communication and Signal Processing (ICCSP)-CHENNAI, India (2017.4.6-2017.4.8)doi:10.1109/ICCSP.2017.8286727 https://ieeexplore.ieee.org/abstract/document/8286727.
8. Groeneveld R "Physical design challenges for billion transistor chips" in IEEE International Conference on Computer Design-Freiberg, Germany(16-18 Sept. 2002), 78–83. doi:10.1109/ICCD.2002.1106751.

https://ieeexplore.ieee.org/abstract/document/1106751.	
Topics Relevant to development of "FOUNDATION SKILLS": Design Methodologies, Algorithmic Graph Theory, Tractable and Intractable Problems. Topics Relevant to development of "EMPLOYABILITY": Layout compaction, Placement and Partitioning, floor planning, Routing.	
Catalogue prepared by	Dr. JOSEPH ANTHONY PRATHAP,
Recommended by the Board of Studies on	19th BOS held on 3rd July 2024
Date of Approval by the Academic Council	24th Academic Council Meeting held on 03/08/2024.

Course Code: ECE3043	**Course Title: Mixed Signal Design** **Type of Course: Professional Core**		**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Analog Electronics, Linear Integrated Circuits, VLSI Design					
Anti-requisites	NIL					
Course Description	The course aims to provide students the exposure to mixed sign design techniques in integrated context. Designs that combine analog circuits with digital signal processing, DSP, are called mixed-signal designs, MSDs					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies					
Course Outcomes	On successful completion of this course the students shall be able to: i) Describe the basic of signals, filters and tools, sampling and aliasing effect in DSP system. ii) Develop the analog and digital filters iii) Understand the effect of noise and signal to noise ratio in the mixed signal design. iv) Describe the data converter using the MSD techniques and its associated trade-offs.					
Course Content:						
Module 1	**Signals, Filters, and Tools, Sampling and Aliasing**	Quiz	Memory Recall based Quizzes	**12 session**		
Sinusoidal signals, Comb Filters, Representation of signals (Fourier series and transform and dirac delta function), Sampling and aliasing: impulse sampling, decimation, sample and hold, interpolation, implementation of sample and hold circuits, Discrete analog integrator						
Module 2	**Analog and Digital Filters**	Assignment / Quiz	Programming task	**11 session**		
Analog Filter: Integrator Building Blocks- Lowpass Filters,Active-RC Integrators, MOSFET-C Integrators, Discrete-Time Integrators, Filtering Topologies- The Bi-linear Transfer Function, Bi-quadratic Transfer Function Digital Filters: SPICE Models for DACs and ADCs, Sinc-Shaped Digital Filters, Bandpass and Highpass Sinc Filters, Interpolation using Sinc Filters, Filtering Topologies:FIR Filters-Stability and Overflow, The Bi-linear Transfer Function, Bi-quadratic Transfer Function						
Module 3	**Data Converter SNR and Data Converter Design Basics.**	Assignment	Memory Recall based Quizzes	**12 session**		
Data Converter SNR: Quantization Noise, Signal-to-Noise Ratio (SNR) Improving SNR using Averaging, Using Feedback to Improve SNR. **Data Converter Design Basics:** Passive Noise-Shaping, Improving SNR and Linearity.						
Module 4	**Noise-Shaping**	Assignment/QUIZ	Programming task	**10 session**		
Noise-Shaping Data Converters: First-Order Noise Shaping, Second-Order Noise-Shaping,. Noise-Shaping Topologies. Bandpass Data Converters: Continuous-Time Bandpass Noise-Shaping, Switched-Capacitor Bandpass Noise-Shaping. High-Speed Data Converter: The Topology, Practical Implementation.						
List of Laboratory Tasks: Nil						

Targeted Application & Tools that can be used:

Targeted Applications: Applications in various fields such as biomedical, optical, wireless networks, aerospace, and consumer products

Professionally Used Software: MATLAB/ Python, Cadence, Vivaldo

Project Work/Assignment:

1. Study of various sensors.

2. Book/Article review:

At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.

3. Presentation:

There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

1. Baker, R. Jacob. CMOS: mixed-signal circuit design. john Wiley & sons, 2nd edition, 2008.

Reference(s):

Reference Book(s):

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis & Design" 4th edition, 2019, TMH publication.
2. R. Jacob Baker, "CMOS circuit design, layout and simulation" 1st edition, 2018, john Wiley & sons
3. Rudy V. dePlassche, CMOS Integrated ADCs and DACs, Springer, Indian 1st edition, 2005.
4. Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1st edition, 1981.
5. Design of Analog filters by R. Schauman, Prentice-Hall 1990, 1st edition.
6. An introduction to Mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 2008.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Video lectures on "CMOS Analog VLSI Design" https://www.digimat.in/nptel/courses/video/117101105/L01.html

2. Video lectures on "CMOS Mixed Signal VLSI Design" by Prof. Maryam Shojaei Baghini, and Prof. Dinesh Sharma , IIT Bombay.https://www.youtube.com/playlist?list=PLLDC70psjvq5vtrb0EdII4xIKA15ec-Ij

E-content:

1. R. C. Frye, "Integration and electrical isolation in CMOS mixed-signal wireless chips," in Proceedings of the IEEE, vol. 89, no. 4, pp. 444-455, April 2001, doi: 10.1109/5.920577. https://ieeexplore.ieee.org/abstract/document/920577
2. Chen, Zhe, Huifeng Zhu, Erxiang Ren, Zheyu Liu, Kaige Jia, Li Luo, Xuan Zhang et al. "Processing near sensor architecture in mixed-signal domain with CMOS image sensor of convolutional-kernel-readout method." IEEE Transactions on Circuits and Systems I: Regular Papers 67, no. 2 (2019): 389-400. https://ieeexplore.ieee.org/abstract/document/8835152
3. Aishwaraya, H. R., Saroja V. Siddamal, Aishwaraya Shetty, and Prateeksha Raikar. "Verifying Mixed Signal ASIC Using SVM." In Advances in Computing and Network Communications: Proceedings of CoCoNet 2020, Volume 1, pp. 167-173. Springer Singapore, 2021. https://link.springer.com/chapter/10.1007/978-981-33-6977-1_14
4. Maheshwari, Sudhanshu. "Logic functions for mixed signal circuit design using analog block." Australian Journal of Electrical and Electronics Engineering 19, no. 3 (2022):

300-305. https://www.tandfonline.com/doi/abs/10.1080/1448837X.2022.2049052

Topics related to development of "FOUNDATION": Representing Signals, Sampling and Aliasing

Topics related to development of "SKILL":Analog Filters: Lowpass filters, Mosfet-C integrator,Filtering Topologies, Digital Filters: ADC, lkowpass, bandpass and highpass filters, Data Converter Design Basics,

Topics related to development of "EMPLOYABILITY": Data Converter SNR, Noise-Shaping Data Converters, Noise-Shaping Data Converters, A High-Speed Data Converter

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3124	**Course Title: VLSI Design** **Type of Course: Program Core Theory**	**L –T - P - C**	3	0	2	4
Version No.	1.0					
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.					
Anti-requisites	**NIL**					
Course Description	This course provides insights into the fundamentals of VLSI Design. The course develops the knowledge of both hardware and software that leads to the design and implementation of analog VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of analog circuit design and layout. This course helps students to become an analog and layout engineer.					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using PARTICIPATIVE LEARNING techniques.					
Course Outcomes	CO1 Explain the basic concepts of VLSI design. CO2 Describe the MOS transistor theory. CO3 Demonstrate the working of various CMOS Sub-circuits and Single Stage Amplifier. CO4 Design a CMOS Amplifier. CO5 Develop a layout, floor planning and testing strategy for a CMOS device.					
Course Content:						

Module 1	**Basic MOS Device Physics**	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions
MOSFET Structure and Symbols, MOS I/V Characteristics, Second-Order Effects, MOS Device Models: MOS Device Layout, MOS Device Capacitances, MOS Small-Signal Model, MOS SPICE models, NMOS Versus PMOS Devices, Long-Channel Versus Short-Channel Devices				

MOS Inverters-Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with N-type MOSFET Load. Introduction SiGe BICMOS Technology.

Module 2	**CMOS Sub-Circuits and Single-Stage Amplifiers**	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions

Stick diagram, layout, large signal analysis of MOS Devices. MOS Switch, MOS Diode/Active Resistor, Current Sinks and Sources, Current Mirrors Current and Voltage References, Single-Stage Amplifiers: Common Source, Common Drain and Common Drain Amplifier.

Module 3	CMOS Amplifiers	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions

Cascode Amplifier and Folder Cascode Amplifier, Design of Differential amplifier: large and Small Signal model, Slew Rate and OPAMP: Ideal vs Practical, Compensation of Opamp, Design of Single and 2 Stage opamp.

Module 4		Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions

ASIC Design flow, Analog Testing, Floor Planning and Layout issues; Low Voltage and Low Power Circuits; Introduction to RF Electronics, Introduction to current mode VLSI design.

List of Laboratory Tasks:

Lab 0: Familiarization of the Cadence Lab.

Lab experiments:

10. Design a MOS transistor (nmos and pmos) using the cadence tool and obtain its Static Characteristics.
    Level 1: Find the relationship between Current ID (Drain current) and Voltage VDS (Drain to Source voltage) for different values of Vgs (Gate to Source voltages). Find ID, Vgs and VDS? In which region the transistor is operating? Level 2: NA
11. **Level 1:** Design and simulate the Invertor Circuits, Create Symbol and
    Level 2: Layout of the Invertor (All 3 Compulsory)
12. **Level 1:** Design and Simulate the NAND gate, Create Symbol and
    Level 2: layout of Nand gate. (All 3 Compulsory)
13. **Level 1:** Design and simulate the NOR gate, Create Symbol and
    Level 2: layout of NOR gate (All 3 are Compulsory)
14. **Level 1:** Design the common source amplifier with given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis
    Level 2: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design.
15. **Level 1:** Design the common drain amplifier with the given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis
    Level 2: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design.
16. **Level 1:** Design the single stage CMOS differential amplifier with the given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis
    Level 2: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design
17. **Level 1:** Design an op-amp with given specification* using given differential amplifier & Common source amplifier in library** and completing the design flow mentioned below. (a) Draw the schematic and symbol and verify the following: DC Analysis, AC

Analysis Transient Analysis

Level 2: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design

18. **Level 1:** Design a 4 bit R-2R based DAC for the given specification and completing the design flow mentioned using given op-amp in the library**.(a) Draw the schematic and symbol and verify the following: DC Analysis, AC Analysis Transient Analysis

    Level 2: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design

(Optional Experiments)

Targeted Application & Tools that can be used:

Targeted Applications: Design of different VLSI Circuits and Sub circuits for industrial applications

Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

7. Find the aspect ratio of the Differential Amplifier for the given gain, slew rate and bandwidth and hence design and verify the differential amplifier in cadence virtuoso.
8. Find the aspect ratio of the 2stage OPAMP for the given gain, slew rate and bandwidth and hence design and verify the differential amplifier in cadence virtuoso.
9. Design the CMOS-based rectifier circuits in cadence virtuoso to obtain the constant output of 2 V, if the peak input ac voltage is 3 V at the frequency of 300 Hz and internal resistance is 2Mohm and Internal capacitance is 10 nF.

Text Books:

5. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001
6. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997

Reference(s):

Reference Books

9. B. Razavi, RF Microelectronics, Prentice-Hall, 1998.
10. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997.
11. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
12. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. 1. Video lectures on "VLSI Devices: Modeling and Simulation" by Prof. Dr. S K Lahiri, IIT KGP
http://www.satishkashyap.com/2013/07/video-lectures-on-vlsi-devices-modeling.html.
2. VLSI Design, IIT Bombay by Prof. A.N. Chandorkarhttps://nptel.ac.in/courses/117/101/117101058/
3. CMOS Digital VLSI Design by Prof. SudebDasgupta, IIT Roorkee.
https://onlinecourses.nptel.ac.in/noc21_ee09/preview

E-content:

11. Konar, Maitraiyee, Rashmi Sahu, and Sudip Kundu. "Improvement of the gain accuracy of the instrumentation amplifier using a very high gain operational amplifier." In *2019 Devices for Integrated Circuit (DevIC)*, pp. 408-412. IEEE, 2019. https://ieeexplore.ieee.org/abstract/document/8783414
12. Kundu, Sudip, and Pradip Mandal. "ISGP: Iterative sequential geometric programming for precise and robust CMOS analog circuit sizing." *Integration* 47, no. 4 (2014): 510-531. https://www.sciencedirect.com/science/article/pii/S0167926014000078
13. Singh, Geetanjali, Srikanta Pal, and Sudip Kundu. "A zero bias highly efficient active diode circuit for piezoelectric energy harvester." *International Journal of*

Nanoparticles 14, no. 2-4 (2022): 106-120. https://www.inderscienceonline.com/doi/abs/10.1504/IJNP.2022.126377
14. Kundu, Sudip, and Pradip Mandal. "A generic and efficient modeling of phase margin of high performance CMOS OpAmps." In *Proceedings of the 2014 IEEE Students' Technology Symposium*, pp. 164-169. IEEE, 2014. https://ieeexplore.ieee.org/abstract/document/6808040
15. Kumar, Vikash, Rishab Mehra, and Aminul Islam. "A 2.5 GHz Low Power, High-${Q} $, Reliable Design of Active Bandpass Filter." *IEEE Transactions on Device and Materials Reliability* 17, no. 1 (2017): 229-244. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7814293

Topics related to the development of "FOUNDATION SKILLS": MOS Transistors,
Topics related to the development of "EMPLOYABILITY": Design of Opamp

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE5010	**Course Title: Design for Testability** **Type of Course: Professional Core**		**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**Basic concepts of Digital Logic Circuits using gates, flip-flops, registers, multiplexers, decoders etc. Basic electronic Circuits and Mathematics and Fundamentals of VLSI Design-based systems.**					
Anti-requisites	**NIL**					
Course Description	**This course provides an in-depth theory of fault analysis, test generation, and design for testability for digital VLSI circuits and systems. Design and manufacturing defect models are introduced along with test generation and fault simulation algorithms targeting the different fault models. Both combinational and sequential logic testing are covered, and different synthesis for testability schemes such as BIST (Built-In-Self-Test), scan path design, and Core based testing are introduced. The course also demonstrates the test compression and compaction schemes such as code-based schemes, linear decompression based schemes and test response compaction.**					
Course Objective	**The objective of the course is to familiarize the learners with the concepts of design for testability and attain EMPLOYABILITY SKILLS by using PARTICIPATIVE LEARNING.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Interpret** the concepts of testing which can help to design a better yield in IC design. 2. **Discuss** the generation of test patterns. 3. **Analyze** the various test generation methods 4. **Summarize** the BIST techniques for improving testability.					
Course Content:						
Module 1	**Introduction to DFT and Fundamentals of DFT**	Assignment/Quizzes	Memory Recall based Quizzes	**10 Sessions**		
Topics: Fundamentals of fault analysis, test generation, and design for testability for digital VLSI circuits and systems, Exhaustive Testing and basics of testing, ASIC Flow, DFT Basics, Chip Fabrication Process, ATE Basics.						
Module 2	**Scan Insertion and compression**	Assignment	Simulation and analysis task	**10 Sessions**		
Topics: Scan Design Basics, Scan Golden Rules, Scan DRC Checks, Scan Insertion, Generate test protocol and understanding, Lock-Up Latches, Basics for Compression, Compression Techniques, On-Chip-Clocking, hierarchical and boundary scan. Controllability and Observability and related issues.						

Module 3	**Introduction to ATPG**	Assignment/Quizzes	Design Analysis	**10 Sessions**
Topics: Fault models, Fault classes, Pattern generation and simulation, simulations and debugging, Diagnosis flow and fault simulation. Automatic Test Pattern Generation (ATPG) in DFT, ATPG classification, Combinational ATPG (e.g. D, PODEM, FAN), Sequential ATPG.				
Module 4	**BIST Architecture, Memory BIST, Logic BIST**	Assignment/Project	Data Analysis	**10 Sessions**
BIST Design Rules, Test Pattern Generation ,Exhaustive Testing ,Pseudo-Random Testing, ,Delay Fault Testing, BIST Architectures circuits with scan chain.				

Targeted Application & Tools that can be used:

Application Area – Hardware design Engineer, DFT engineer, VLSI design Engineer.

Professionally Used Software: Cadence-Modus, Tessent

Project work/Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment:-

Project 1. The emphasis on online education is increasing now-a-days, based on the current scenario, one organization designs a prototype for smooth and interactive learning platforms, consider the design with following functions embedded:

1.Locking of meeting after 10 minutes

2.Control over the class by the instructor

You are free to add functions. Enlist the test cases and pattern you will use to test the design.

Assignment 1. A block level design is given as a project to design engineer, it is given for DFT engineer for testing, he/she needs to insert scan and generate patterns, to get the required test coverage. What will be your approach for the same?

Assignment 2. ALU is the heart of the processors, The basics ones start with 4 bit and beyond. Analyze the test patterns for 4 bit ALU in HDL environment and use test patterns for testing the design.

Textbook(s):

1. Laung-Terng Wang, Cheng-Wen Wu, and Xiaoqing Wen, "*VLSI Test Principles and Architectures*" The
Morgan Kaufmann, 2013

References:

Reference Book(s):

1. Z.Navabi, "*Digital System Test and Testable Design*", Springer, 2011.
2. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, System-on-Chip Test Architectures: Nanometer Design for Testability, Morgan Kaufmann, First Edition, 2010.
3. Huertas JL, (editor), "Test and design-for-testability in mixed-signal integrated circuits", The Netherlands: Kluwer Academic; 2004.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Lecture videos for design for testability: https://onlinecourses.nptel.ac.in/noc20_ee76
2. PPT on Design for Testability, Link : https://eecs.ceas.uc.edu/~jonewb/DFTnew.pdf
3. https://www.youtube.com/watch?v=MgCFUO2BrkQ
4. https://www.youtube.com/watch?v=MEaMm423t0w&list=PLZjlBaHNchvOFBWBAtAP9e

xwQgYpKqsO4

5. https://www.geeksforgeeks.org/design-for-testability-dft-in-software-testing/
6. https://web.stanford.edu/class/archive/ee/ee371/ee371.1066/lectures/lect_14.2up.pdf

E-Content

1. Bukovjan, Peter, Meryem Marzouki, and Walid Maroufi. "Design for testability reuse in synthesis for testability." *Proceedings. XII Symposium on Integrated Circuits and Systems Design (Cat. No. PR00387)*. IEEE, 1999.
2. Williams, Thomas W. "Design for Testability: The Path to Deep Submicron." *14th Asian Test Symposium (ATS'05)*. IEEE, 2005.
3. Williams, Thomas W. "Design for testability: today and in the future." *VLSI Design, International Conference on*. IEEE Computer Society, 1997.
4. Williams, Thomas W., and Kenneth P. Parker. "Design for testability—A survey." *Proceedings of the IEEE* 71.1 (1983): 98-112.
5.Ghosh, Indradeep, Niraj K. Jha, and Sujit Dey. "A low overhead design for testability and test generation technique for core-based systems-on-a-chip." *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* 18.11 (1999): 1661-1676.

Topics relevant to "EMPLOYABILITY SKILLS": Fault models, Fault classes, Pattern generation and simulation, simulations and debugging, Diagnosis flow and fault simulation ATPG, BIST, Projects based on Various design for testability recently published research articles for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3126**	**Course Title: Physical Design and Automation** **Type of Course: Professional Core**		**L- T-P- C**	3	0	2	4
Version No.	2.0					
Course Pre-requisites	Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using real time algorithms used in VLSI industry.					
Course Outcomes	On successful completion of this course the students shall be able to: 9. Describe various graph algorithms. 10. Define computational complexity of different physical design algorithms. 11. Employ various algorithms for Partitioning, Placement and Floor planning. 12. Illustrate different types of routing algorithms.					
Course Content:						
Module 1	**Design automation tools**	Quiz	Memory Recall based Quizzes			**10 classes**
Topics: VLSI design automation tools- algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools.						
Module 2	**Layout compaction, Placement and Partitioning**	Assignment	Design Analysis			**9 classes**
Topics: Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.						
Module 3	**Floor planning and Routing**	Assignment	Design Analysis			**9 classes**
Topics: Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.						
Module 4	**Logic Synthesis & High Level Synthesis**	Assignment	Programming and simulation			**9 classes**

Topics:
Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis. Hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

List of Laboratory Tasks:

Experiment No. 1: Study of Resistors, Measuring instruments and DC Power Supply.
Level 1: Identification of resistor values from color bands and verification with Multimeter.
Level 2: Connecting a resistive circuit to a DC Power Supply and observing the input and output values using Voltmeters, Ammeters and hence calculate resistance values.

Experiment No. 2: Study of Reactive components, Multimeter, CRO and Function Generator.
Level 1: Identification of various types of capacitive and inductive components and verification with Multimeter.
Level 2: Connecting a reactive circuit to a function generator and observing the input and output waveform on CRO and calculation of Reactance and Impedance.

Experiment No. 3: Study of PN-Junction Diode Characteristics in Forward and Reverse Bias Conditions.
Level 1: Carry out the experiment to find cut-in voltage on forward characteristics for Silicon P-N Junction diode.
Level 2: Carry out experiment to plot VI Characteristics of Silicon P-N Junction Diode in both forward and reverse biased conditions for Si P-N Junction diode.

Experiment No. 4: To observe the output waveform of half wave and full wave rectifier circuit and compute ripple factor and efficiency
Level 1:
Identify the components required for a rectifier circuit, rig up the circuit, and sketch the output waveforms without filter.
Level 2:
Rig up the rectifier circuit with RC filter, observe the output waveforms, determine the efficiency and ripple factor.

Experiment 5: To construct clipping and clamping circuits for different reference voltages and to verify the responses.
Level 1:
Identify the components required for building a Clipper / Clamper circuit. Rig up the circuit according to the circuit diagram given and sketch the output waveform.
Level 2:
Given a sinusoidal input of 10 V p-p, implement a positive / negative clipper with output clipped at 2 V.

Experiment No. 6: Study of Bipolar Junction Transistor in different regions of operation.
Level 1: Carry out the experiment to understand the importance of active, cut off and saturation regions.
Level 2: Carry out the experiment to design and analyze the operation of transistor as switch.

Experiment 7: To calculate various parameters of emitter follower circuit using BJT
Level 1:
Identify the components required to implement an emitter follower circuit. Rig up the circuit and observe the variations in output waveform with respect to the variations in input waveform.
Level 2:

Determine the values of Zin input impedance and Zout output impedance for Emitter Follower.

Experiment 8: To sketch input and output characteristics of a transistor and to calculate input/ output resistance and current gain using h-parameters
Level 1:
Setup an experiment to sketch the input and output characteristics of a transistor (BJT).
Level 2:
From the input and output characteristics obtained determine parameters such as input resistance, output resistance and gain of the transistor.
Experiment 9: To Implement RC Coupled amplifier using a BJT and sketch the frequency response.
Level 1: Identify the components required to implement an RC coupled amplifier circuit. Rig up the circuit and sketch the frequency response.
Level 2: From the frequency response curve determine the value of the mid band gain and the bandwidth.

Targeted Application & Tools that can be used:
Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.
Professionally Used Software: VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project work/Assignment:

Project Assignment:

9. Develop a heuristic algorithm for finding a maximum bipartite subgraph in circle graphs.
10. Suggest modifications to the Kernighan-Lin algorithm to speed up the algorithm.
11. Design an efficient heuristic algorithm based on maze routing to simultaneously route two 2-terminal nets on a grid graph. Compare the routing produced by this algorithm with that produced by Lee's maze router by routing one net at a time.
12. Implement the approximation algorithm for finding a *k*-independent set in circle graphs. Experimentally evaluate the performance of the algorithm by implementing an exponential time complexity algorithm for finding a *k*-independent set.

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

5. **S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.**
6. **M. L. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI circuits", Kluwer, 2001.**

Reference(s):

7. Stephen Trimberger, "Introduction to CAD for VLSI", Kluwer Academic publisher, 2002.
8. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, 2nd edition.
9. G. Hachtel and F. Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer, 1998. 3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers; 3rd ed., 1999.

Online and Web resource (s):

13. https://nptel.ac.in/courses/106/106/106106088/
14. https://cse.ucsd.edu/faculty-research/vlsicad-computer-aided-design
15. http://www.facweb.iitkgp.ac.in/~isg/CAD/
16. https://www.youtube.com/watch?v=hJTK5nj1iq8
17. https://www.youtube.com/watch?v=WLdbujc-aH4
18. https://www.youtube.com/watch?v=zkFRfmySFOw

E-Content:

9. H. Martin Bucker and Christian Sohr Bucker "Reformulating a Breadth-First Search Algorithm on an Undirected Graph in the Language of Linear Algebra" in IEEE 2014 International Conference on Mathematics and Computers in Sciences and in Industry, 33–35. doi:10.1109/MCSI.2014.40 **https://ieeexplore.ieee.org/abstract/document/7046157**

10. Farnaz Towhidi, Arash Habibi Lashkari "Binary Decision Diagram (BDD)" in IEEE 2009 International conference on future computer and communication, 03-05 April 2009, doi:10.1109/ICFCC.2009.31 https://ieeexplore.ieee.org/abstract/document/5189833.

11. Archana K Rajan, Deepika Bhaiya "VLSI partitioning using parallel kernighan lin algorithm" in IEEE 2017 International Conference on Communication and Signal Processing (ICCSP)-CHENNAI, India (2017.4.6-2017.4.8)doi:10.1109/ICCSP.2017.8286727 https://ieeexplore.ieee.org/abstract/document/8286727.

12. Groeneveld R "Physical design challenges for billion transistor chips" in IEEE International Conference on Computer Design-Freiberg, Germany(16-18 Sept. 2002), 78–83. doi:10.1109/ICCD.2002.1106751. https://ieeexplore.ieee.org/abstract/document/1106751.

Topics Relevant to development of "FOUNDATION SKILLS": Design Methodologies, Algorithmic Graph Theory, Tractable and Intractable Problems.

Topics Relevant to development of "EMPLOYABILITY": Layout compaction, Placement and Partitioning, floor planning, Routing.

Catalogue prepared by	Dr. JOSEPH ANTHONY PRATHAP,
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

DISCIPLINE ELECTIVES

GENERAL BASKET

Course Code: **ECE3015**	**Course Title: Measuring Instruments and Sensors** **Type of Course: Discipline Elective- General Bakset**	**L-T-P-C**	**3**	**0**	**0**	**3**
Version No.	1.0					
Course Pre-requisites	[1] Linear Integrated circuits-ECE 3001 [2] Digital Electronics-ECE2002					
Anti-requisites	**NIL**					
Course Description	This course deals with measuring instruments used for indicating, measuring and recording quantities. It is essential to learn its usefulness in the design of automatic process control, home automation systems, large integrated computer based system and their calibrations. Application of measurement and instrument helps students to calibrate industrial equipment's, design instruments for various application in Bio medical, Electrical, Mechanical fields and enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools and hardware interfacing techniques. It also provides a practice to the construction of testing and measuring set up for electronic systems and to have a deep understanding about instrumentation concepts that will result in basic process control in industry to manufacture quality products.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Measuring Instruments and Sensors and attain EMPLOYABILITY SKILLS through _PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Discuss the concepts of measuring systems and error in measurement. 2. Demonstrate various types of Analog and Digital Instruments. 3. Analyze various types of sensors and transducers. 4. Acquire data using sensor interfaces and Lab-VIEW. 5. Compute the unknown parameters using bridge circuits.					
Course Content:						
Module 1	Measurements and Measuring Systems, Error in measurement and their statistical Analysis	Assignment/quiz	Programming Task	**13Sessions**		
Topics: Significance of measurements, Methods of Measurement- Direct and Indirect Methods, True Value, Static Error, Static Correction, Error Calibration Curve, Accuracy and Precision, Static Sensitivity, Linearity. Hysteresis, Dead Time, Dead Zone, Resolution or Discrimination, Types of Errors, Arithmetic Mean, Range, Deviation, Average Deviation, Standard Deviation (S.D.), Variance.						
Module 2	Storage and display devices	Assignment/quiz	Data collection and simulation task	**12 Sessions**		
Topics: D.C. and A.C. Bridges (Measurement of resistance, capacitance and Inductance), Digital Voltmeter (DVM), Digital Multimeter (DMM), Square and pulse generator, Relaxation						

oscillator.					
Module 3	Sensors and Transducers	Assignment/quiz	Data collection and simulation task		**15 Sessions**

Topics:
Basic Principles of Operation, Different types of transducers, Resistive, Capacitive, Linear Variable differential transducer (LVDT), piezoelectric transducer, Temperature transducers, Pressure Transducers, Proximity Sensor.

List of Laboratory Tasks:

Experiment No. 1: Familiarization with virtual instrumentation using Lab VIEW Software
Level 1: To understand the principles of Virtual Instrumentation (VI) and learn the basics for creating Virtual Instrument and implement a circuit diagram to convert degree C to F using VI tools.
Level 2: NA

Experiment No. 2: Implementation of digital combinational circuits and loops
Level 1: Draw and implement the circuit diagram of Half Adder and Full Adder circuit using Boolean gates and verify output using truth table, generate a saw tooth waveform using while loop and find the sum of N natural numbers using for loop.
Level 2: Interpretation of a full adder circuit implemented in level 1 for Ripple carry adder and verifying the output.

Experiment No. 3: Implementation of case structures and arrays
Level 1: Draw a circuit diagram to implement conversion of temperature using case structures, insertion of element in an array and for computing maximum, minimum, average and the array size.
Level 2: Interpretation of array inserted with an element in level 1 to sort in ascending order and verifying the result.

Experiment No. 4: Measurement of unknown resistance using Wheatstone bridge
Level 1: Implement the circuit diagram for basic Wheatstone bridge collecting proper components and verifying the result.
Level 2: Interpretation of Wheatstone bridge usage for improving the sensitivity of any sensor output.

Experiment No. 5: Measurement of unknown inductance using Maxwell's inductance bridge
Level 1: Implement the circuit diagram for basic Maxwell's inductance bridge using appropriate components and verify the results.
Level 2: Interpret the usage of bridge for instrumentation purposes.

Experiment No. 6: Measurement of component values and voltage drop across series combination of resistors using NI ELVIS II+ Workstation
Level 1: Identify the component values and build a voltage divider circuit on the NI ELVIS II+ protoboard to calculate voltage drop across resistances for computing static error.
Level 2: Build a voltage divider circuit as implemented in level 1 using 5.5 kΩ and 10 kΩ resistors and compute the static error.

Experiment No. 7: Measurement of phase difference and power factor of a series R-L and R-C circuit using NI ELVIS II+ Workstation
Level 1: Implement the RL and RC circuits by collecting required components and verify the results.
Level 2: Build the RL and RC circuits as implemented in level 1 using given component (3.5kΩ resistor, 2uf capacitor and 3 H inductance) and verify the output.

Experiment No. 8: Measurement of temperature using RTD, NI myDAQ and Lab-VIEW
Level 1: Draw the circuit using proper elements and develop the code to measure the

temperature and verify the result.
Level 2: Level 2: Usage of temperature measurement for controlling of air conditioner.

Targeted Application & Tools that can be used:
Application Area is AWA-Biosensor BOD analyser,bio medical field ,Analog devices, Automatic process control, chemical sensors and analytical instruments
Professionally Used Software: MATLAB/ Lab VIEW NI Lab-VIEW
NI ELVIS II+ Workstation, NI myDAQ

Text Book(s):

1. A. K. Sawhney, "Electronics and Electrical Measurements", Dhanpat Rai and Sons. 4th Edition, 2017.

References

1. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press / PHI. 2nd Edition, 2006.
2. H. S. Kalsi, "Electronic Instrumentation", McGraw Hill., 4th Edition, 2018.
3. Online videos of lab-VIEW compatible NI devices., 2nd Edition, 2019.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on measuring instruments and sensors - https://nptel.ac.in/courses/108/105/108105153/
2. Coursera - https://www.coursera.org/learn/sensors-circuit-interface
3. Udemy - https://www.udemy.com/course/electronic-measurements-and-instrumentation/

E-Content:

1. H. Liu, W. Sun, Q. Chen and S. Xu, "Thin-Film Thermocouple Array for Time-Resolved Local Temperature Mapping," in *IEEE Electron Device Letters*, vol. 32, no. 11, pp. 1606-1608, Nov. 2011, doi: 10.1109/LED.2011.2165522.
2. S. F. Ali and N. Mandal, "Design and Development of an Electronic Level Transmitter Using Inter Digital Capacitor," in *IEEE Sensors Journal*, vol. 19, no. 13, pp. 5179-5185, 1 July1, 2019, doi: 10.1109/JSEN.2019.2903296.
3. S. F. Ali, P. Maurya and N. Mandal, "Development of PLC Based Reluctance type Target Flow Control System," *2020 IEEE International Conference for Innovation in Technology (INOCON)*, 2020, pp. 1-5, doi: 10.1109/INOCON50539.2020.9298292.
4. B. Mondal, R. Sarkar and N. Mandal, "Design and Implementation of an RF-Based Wireless Displacement Transmitter," in *IEEE Sensors Journal*, vol. 20, no. 3, pp. 1383-1392, 1 Feb.1, 2020, doi: 10.1109/JSEN.2019.2947318.

Topics relevant to "EMPLOYABILITY SKILLS": Methods of Measurement, types of error, resolution for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Ajit Kumar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE3017</td><td colspan="4">Course Title: Linear Algebra for Communication Engineering
Type of Course: Discipline Elective-General Bakset</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9"></td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">The course emphasizeson the applications of linear algebra in communication engineering. This course finds applications in various fields of engineering, like Signal Processing, Coding Theory, Machine Learning, Computer Graphics and Computer Vision. The course provides insights into the methods for reducing the problem from many areas of engineering into one in linear algebra extended to multi-dimensional spaces. The course also deals with techniques to solve problems analytically.</td></tr>
<tr><td>Course Objective</td><td colspan="9">The objective of the course is to familiarize the learners with the concepts of Linear Algebra for Communication Engineering and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
1. Developthe algebraic methods essential for the study of systems of linear equations, matrix algebra, vector spaces.
2. Apply the concepts of determinants and eigenvalues to discriminate between invertible and non-invertible matrices for diagonalization and orthogonalization.
3. Execute linear transformations of finite dimensional vector spaces to compose their matrices in specific bases.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="3">Matrices and Gaussian Elimination</td><td colspan="3">Assignment</td><td colspan="2">Programming (Curve Fitting) Task</td><td>10 Sessions</td></tr>
<tr><td colspan="10">Topics:
Introduction, the geometry of linear equations, elimination with matrices, multiplication and inverse matrices, factorization, column space and null space, Solution to homogenous equations, Row reduced form, Independence, Basis and Dimensions, the four fundamental sub-spaces, matrix spaces.</td></tr>
<tr><td>Module 2</td><td colspan="3">Least squares, Determinants and Eigenvalues</td><td colspan="3">Assignment</td><td colspan="2">Programming Task</td><td>10Sessions</td></tr>
<tr><td colspan="10">Topics:
Orthogonal vectors and subspaces, projection onto subspaces, projection matrices and least squares, orthogonal matrices and Gram-Schmidt, properties of determinants, determinant formulas and cofactors, Cramer’s rule, eigenvalues and eigenvectors, diagonalization and powers, differential equations, Fourier Series.</td></tr>
<tr><td>Module 3</td><td colspan="3">Positive Definite Matrices and Applications</td><td colspan="3">Project Assignment</td><td colspan="2">Programming and Simulation Task</td><td>14Sessions</td></tr>
<tr><td colspan="10">Topics:
Symmetric matrices and positive definiteness, positive definite matrices and minima, Linear transformations and their matrices, change of basis, Singular Value Decomposition, Fourier Transform, similar matrices and Jordan form.</td></tr>
</table>

Module 4	Optimization	Assignment	Programming Task	11 sessions
Topics: Matrix Games, Linear Programming—Geometric Method, Linear Programming—Simplex Method, Duality				
Targeted Application & Tools that can be used: Applications: Signal Processing, Coding Theory, Machine Learning, Computer Vision, Computer Graphics Tools: Matlab, Jupyter Notebook, TensorFlow				
Textbook(s): David C. Lay, "Linear Algebra and Its Applications", (6th Edition), Pearson (2020)				
References: **1.** Gilbert Strang, "Introduction to Linear Algebra", 5th Edition-Wellesley Cambridge Press (2016). 2. Ron Larson, David C. Falvo, "Elementary Linear Algebra", 8th Edition- Brooks Cole (2016). 3. D.C. Lay, S.R. Lay, J.J. McDonald, "Linear algebra and its applications**"** **Online Resources (e-books, notes, ppts, video lectures etc.):** **1.** Linear Algebra | Khan Academy **2.** Linear Algebra | MIT OpenCourseWare **E-content** 1. Hansen Anders C. 2010 "Infinite-dimensional numerical linear algebra: theory and applications", Proc. R. Soc. A. 4663539–3559, http://doi.org/10.1098/rspa.2009.0617 2. Calvetti, D., Reichel, L., Sgallari, F. (1999). Applications of Anti-Gauss Quadrature Rules in Linear Algebra. In: Gautschi, W., Opfer, G., Golub, G.H. (eds) Applications and Computation of Orthogonal Polynomials. International Series of Numerical Mathematics, vol 131. Birkhäuser, Basel. https://doi.org/10.1007/978-3-0348-8685-7_3 3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home				
Topics relevant to "EMPLOYABILITY SKILLS": Cramer's rule, Fourier Transform for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.				
Catalogue prepared by	Dr. Sumantra Chaudhuri			
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024			
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024			

Course Code: **ECE 3018**	**Course Title: Engineering Applications using Software Tools** **Type of Course: Discipline Elective- General Bakset**		**L- T-P- C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	**Nil**						
Anti-requisites	**NIL**						
Course Description	The purpose of this course is to enable the students to use certain software tools which can be used for Engineering Applications. There is a lot of demand for software tools for various Engineering applications, and this course will cater to that demand area. The software tools that will be introduced are MATLAB, SIMULINK and NI LabVIEW. This is a laboratory integrated course.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Engineering Applications using Software Tools and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.						
Course Outcomes	On successful completion of this course the students shall be able to: (1) Use MATLAB to solve basic engineering problems (2) Solve ordinary differential equations in MATLAB using various methods (3) Use SIMULINK to solve electronics related real world problems. (4) Apply interfacing techniques to interface different components using NI myDAQ						
Course Content:							
Module 1	MATLAB	Assignment/ Quiz	Simulation Task	**10 Sessions**			
Topics: MATLAB basics - The MATLAB environment. MATLAB scripts and functions (m-files) - Simple sequential algorithms - Control structures (if…then, loops). User defined functions and function handles. Symbolic math, Numerical Integration and differentiation, Transforms. Solution of Ordinary Differential Equations. Data modeling -Linear regression, Optimization, Statistical analysis of data, reading from and writing to different data files, Curve fitting.							
Module 2	SIMULINK	Assignment / Quiz	Simulation Task	**9 Sessions**			
Topics: SIMULINK: Modelling differential equations. Practical examples of electrical circuits and mechanical systems. Representing model as a subsystem. Use MATLAB Function in SIMULINK. S Function. Examples using S Function, Modelling physical systems using Simscape							
Module 3	LabVIEW	Assignment/ Quiz	Simulation Task	**10 Sessions**			
LabVIEW: Data types, software constructs, and Graphical User Interface (GUI) elements. Variables and functions. Simple design patterns. SubVI design.							
Module 4	MyDAQ	Assignment/ Quiz	Simulation Task	**10 Classes**			
Topics: MyDAQ: Introduction to Data Acquisition and Sampling Theory, Filtering Signals, Digital Thermometer, DC motor speed control. Interfacing certain sensors and display devices using myDAQ.							

Targeted Application & Tools that can be used:

Application: Learning about softwares which are widely used in academia as well as research will help the student in getting a job in various companies which utilizes these softwares. A student will be able to find job in the following companies

1. Mathworks
2. NI
3. Any company/ research organization which uses these softwares

Professionally Used Software:

MATLAB/SIMULINK, NI LabVIEW, myDAQ

Textbook(s):

1. Stephen J Chapman, Essentials of MATLAB Programming, Third Edition, Cenage Learning, 2016
2. Steven T Karris, Introduction to SIMULINK with Engineering Applications, Third Edition, Orchard Publications, 2016
3. Jovitha Jerome, 'Virtual Instrumentation using LabVIEW', PHI, Second Print, 2011

References

1. **www.mathworks.in**
2. **www.ni.com**

Online Resources (e-books, notes, ppts, video lectures etc.):

4. Video lectures on various courses available online in MATLAB https://www.matlabacademy.mathworks.in

E-content:

1. Yi Luo, Cheng Gang Li, Feng Zhang, Kai Wang "The real-times monitor system based on LabVIEW", Proceedings of 2011 International Conference on Computer Science and Network Technology https://ieeexplore.ieee.org/document/6182095

2. Pedro Ponce Cruz; Arturo Molina Gutiérrez, "LabVIEW for intelligent control research and education", 2010 4th IEEE International Conference on E-Learning in Industrial Electronics https://ieeexplore.ieee.org/document/5669840

3. Hong Min Wang; Dan Dan Li; Ping Xue; Jie Zhu; Hai Bo Li, "LabVIEW-based data acquisition system design", Proceedings of 2012 International Conference on Measurement, Information and Control https://ieeexplore.ieee.org/abstract/document/6273386

4. M. A. Amer; M. Cortina-Puig; V. Martínez; J. Cruz; J. Morral, "Implementation of a LabVIEW-based virtual laboratory", 2015 IEEE International Conference on Industrial Technology (ICIT) https://ieeexplore.ieee.org/document/7125583

Topics relevant to "EMPLOYABILITY SKILLS": NI MULTISIM, MATLAB, Data modeling for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Diana Steffi Mr. Sunil Kumar Dasari Mr. Kiran Kale
Recommended by	BOS Meeting NO: 19th BOS held on 06/07/2024

the Board of Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3019	**Course Title: Python Programming for Electronics Applications** **Type of Course: Discipline Elective-General Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Fundamentals of python programming and basics of electronics such KVL, KCL, modulation techniques, transistors					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to understand the need of python in various electronics applications. The course is introductory in nature, involving knowledge of programming concepts. This course introduces the process of simulation and also provides basic theory lectures to help understand how simulations can be used to learn about basic concepts related to electronics. This course targets at developing basic programing skills using python in order to perform signal processing, circuit simulation etc. using the basic knowledge. The benefit of this course aims at applying the fundamentals learnt into a realization in the electronics industry.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Python Programming for Electronics Applications and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Recall the basics of python programming language 2) Understand the basic concepts of electronic circuits using python. 3) Write simple programs using python 4) Demonstrate the use of python to implement various circuits related to different areas of electronics					
Course Content:						
Module 1	**Fundamentals of Python Programming**	Assignment/ Quiz	Programming and simulation Task	**12 Sessions**		
Topics: Variables, Conditional Statement, Boolean expressions, If/Else statement, Loops, Functions, Objects, Lists, Files , Classes						
Module 2	**Circuit Simulation**	Assignment / Quiz	Programming and Simulation task	**12 Sessions**		
Topics: An Introduction to Electric Circuits simulation, verification of Ohm's law, simulation of electrical power and energy, Resistance, Series and parallel networks, Electromagnetism, Transistors, Logic Gates,						
Module 3	**Signal Processing Using Python**	Assignment / Quiz	Programming and Simulation task	**15 Sessions**		
Topics: Python programming for Continuous time signal processing, Discrete time signal processing, Perform Convolution of two sequences, correlation, FFT, Filters using python						

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Python finds wide application in the area of signal Processing, image processing, control engineering, IoT, power Electronics, Industrial Automation Application, Machine Learning, AI, etc.

The students will be able to join a profession such as Hardware Developer, Web Developer, Game Developer, Data Analyst etc.

Professionally Used Software: Anaconda, Jupyter notebook / Google Colaboratory – on cloud / Spyder can be used to write code to build and simulate the circuits, and perform analysis of the same.

Text Book(s):

11. J. V. Guttag," Introduction to computation and programming using python: with applications to understanding data". PHI – 2016

12. J. O Bird, "Electrical Circuit Theory AND Technology", Newnes, Burlington, 2003

Reference(s):

Reference Book(s):

1. C. Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013
2. A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition

Online Resources (e-books, notes, ppts, video lectures etc.):

5. Documentation of signal Processing Toolbox available **https://docs.scipy.org/doc/scipy/reference/tutorial/signal.html**

2. Document with python programs is available at - https://tbc-python.fossee.in/completed-books/

3. https://presiuniv.knimbus.com/user#/home

E-content:

1. Brute Force Root Finding https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=DOAB_1_8589936723

2. Programming for Computations - Python: A Gentle Introduction to Numerical Simulations with Python https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=DOAB_1_8589936723

Topics relevant to "EMPLOYABILITY SKILLS": Electric Circuits simulation, application of operational amplifiers for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Kehkeshan Jalall S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3020**	**Course Title: Computational Intelligence and Machine Learning** **Type of Course: Discipline Elective-General Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of matrix operations, probability theory, vector and array representation.					
Anti-requisites	**NIL**					
Course Description	The course aims to make the students to understand the mathematical approaches for machine learning and computational intelligence algorithms. This course covers the basic concepts of Neural Networks which will enable the students to understand the concepts of machine learning. Concepts of Linear models for regression and classification will be discussed in such way that students can able to perform data analysis in practical applications. In this course, Computational intelligence algorithms are included to get better understanding of Artificial intelligence.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Computational Intelligence and Machine Learning and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Analyze and fundamental concepts of neural networks 2. Implement ML algorithms to regression, classification, clustering, and dimensionality reduction 3. Categorize the various pattern recognition techniques using machine learning into supervised and unsupervised.					
Course Content:						
Module 1	Fundamentals of ANN	Assignment	Memory Recall based Quizzes	**13 *Sessions***		
Topics: Introduction To Artificial Neural Networks (ANNs), Models Of A Neuron, Neural Networks-Associated Graphs And Feedback, Network Architectures And Knowledge Representation, Learning Algorithms. Perceptron, Perceptron Convergence Theorem, Relation Between The Perceptron And Bayes Classifier For A Gaussian Environment, and The Back-Propagation Algorithm. Introduction to Recurrent Neural networks						
Module 2	Regression and classification	Assignment/ mini project	Memory Recall based Quizzes	**13 *Sessions***		
Topics: Linear models for regression and classification: Polynomial curve fitting. Probability theory-Bayesian probabilities, and Gaussian distribution, Linear basis function models for regression - Maximum likelihood and least squares, Regularized least squares, Bias variance decomposition-Bayesian linear regression, linear discriminant analysis (LDA), Principal Component Analysis (PCA), Independent Component Analysis (ICA). Kernal linear discriminant analysis (KLDA).						
Module 3	Kernel methods, Computational algorithms	Assignment/ mini project	Programing / simulation	**14 *Sessions***		
Topics: Kernel methods: Dual representations-Constructing kernels, K- means Algorithm, Fuzzy K-means Algorithm, Kohonen Self organizing Maps, Maximum margin classifier (Support Vector						

Machine), Particle swarm optimization--Ant colony optimization- Bacterial foraging. Genetic algorithm.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: This course is contributed for placement in data science companies, research & development work and also useful to know the existing & developing Artificial Intelligence.

Professionally Used Software: MatLab, Phython

Text Books:

1. Pattern recognition and machine learning, Christopher M. Bishop, TMH, Springer, 2010

2. Algorithm Collections for Digital Signal Processing Applications Using Matlab, E.S. Gopi, Springer.

Reference(s):

Reference Books

1. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://youtube.com/playlist?list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77
2. https://archive.ics.uci.edu/ml/index.php

3.https://presiuniv.knimbus.com/user#/home

E-content:

1. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu, Lin Ye,
A review of the application of machine learning in water quality evaluation, Eco-Environment & Health,
2022, ISSN 2772-9850,
https://doi.org/10.1016/j.eehl.2022.06.001.

2. Lin Li, Yici Cai, Qiang Zhou, A survey on machine learning-based routing for VLSI physical design,
Integration, Volume 86, 2022, Pages 51-56, ISSN 0167-9260,
https://doi.org/10.1016/j.vlsi.2022.05.003.

3. Vijaya B. Kolachalama, Machine learning and pre-medical education, Artificial Intelligence in Medicine,
Volume 129, 2022, 102313, ISSN 0933-3657,
https://doi.org/10.1016/j.artmed.2022.102313.

4. Sergio Ledesma, Mario-Alberto Ibarra-Manzano, Dora-Luz Almanza-Ojeda, Juan Gabriel Avina-Cervantes, Eduardo Cabal-Yepez, On removing conflicts for machine learning, Expert Systems with Applications,
Volume 206, 2022, 117835, ISSN 0957-4174,
https://doi.org/10.1016/j.eswa.2022.117835

Topics relevant to "EMPLOYABILITY SKILLS": Artificial Neural Networks, Learning Algorithms, linear regression for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. G Tirumala Vasu
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024

Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3021**	**Course Title:** **Optoelectronic Materials** **Type of Course:** **Discipline Elective-General Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Fundamentals of basic electronic circuit components and relevant semiconductor physics concepts.					
Anti-requisites	NIL					
Course Description	The course introduces the Materials Science and Engineering basics as well as the applications in optoelectronics and semiconductor devices. This course provides an introduction to physics of solid-state materials. The course also deals with a fundamental description of bonding in crystalline solids, electronic band structure and the fundamentals of different optoelectronic devices.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Optoelectronic Materials and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Describe semiconductor materials, their properties and processing techniques. 2. Interpret the wave nature of light and physics of solid state. 3. Discuss the various display and optical detection devices. 4. Employ the concepts learnt to model new detection devices.					
Course Content:						
Module 1	**Electronic Structure and Properties of Materials**	Assignment/quiz	Programming & Simulation task	**14 classes**		
Topics: Free electron theory, Introduction to the role of lattice, Review of reciprocal lattice, Brillouin zone, free electron band diagram, potential in a crystal, conductivity in relation to band structure, Band structure of metals and semiconductors, empirical estimates of conductivity in metals and alloys. Semiconductor heterostructure- Lattice-matched-layers, Strained-Layer Epitaxy and Quantum well structures, Semiconductors - band diagrams, direct and indirect bandgap, degenerate and nondegenerate semiconductors, intrinsic and extrinsic semiconductors, determination of dopant levels and mobility measurements. Dielectric materials - dielectric constants and polarization, linear dielectric materials, capacitors and insulators, C-V characterization.						
Module 2	**Light And Solid State Physics**	Assignment/quiz	Programming & Simulation task	**12 classes**		
Topics: Wave nature of light, Polarization, Interference, Diffraction, Light Source, review of Quantum Mechanical concept, Interaction of photons with electrons and holes in a semiconductor, Review of Solid-State Physics, Review of Semiconductor Physics and Semiconductor Junction Device.						
Module 3	**Display Devices, Lasers and Optical Detection Devices**	Assignment/quiz	Programming & Simulation task	**14 classes**		
Topics:						

Injection Luminescence, LED, LED characteristics, Modulation bandwidth, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, Quantum well Laser, laser applications.
Photo detector, General characteristic, Responsivity, Thermal detector, Photo Devices, Photo Conductors, Photo diodes, Detector Performance. Buck converter, Boost converter, Bi-directional converter, Fly-back converter, PWM pulses generation, isolation and gate drive circuits.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Application domain: Telecommunication, Medical Equipment, Automatic Access Control Systems, Military Services Ocean Navigation, Remote Monitoring and Control, Optical fiber communication.

Tools: LABVIEW, MATLAB

Text Book(s)

1. Pallab Bhattacharya "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006.
2. Jasprit Singh, "Opto Electronics – As Introduction to materials and devices", McGraw-Hill International Edition, 1998.

Reference(s):

Reference Book(s):

1. L. Solymar and D. Walsh, "Electrical Properties of Materials", Oxford University press, 1998

2. Rolf E. Hummel, "Electronic Properties of Materials: An Introduction for Engineers", Springer Verlag, 1985.

3. Timp. G, "Nanotechnology", AIP press/Springer, 1999.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Online NPTEL videos on Photonics and integrated circuits by Prof. Shankar Kumar Selvaraj, IISC Bangalore https://nptel.ac.in/courses/108/108/108108174/
2. Online NPTEL videos on Photonics and integrated circuits by Dr. Srinivas Talabatulla https://nptel.ac.in/courses/117/108/117108142/
3. Online courses on Optoelectronics https://onlinecourses.nptel.ac.in/noc21_ee35
4. https://presiuniv.Knimbus.com/user#/home

E-content:

13. Manufacturing of Er3+-doped planar waveguides on silica-on-silicon using femtosecond laser-induced plasma Paramita Pal, Eric Kumi-Barimah, Benjamin Dawson, Gin Jose. Optics Communications Volume 522, 1 November 2022, 128614 https://doi.org/10.1016/j.optcom.2022.128614.
14. The composite planar waveguide structure consisting of the linearly graded-index layer and the nonlinear layer formed with an increasing the electric field S.E. Savotchenko, Optik Volume 252, February 2022, 168542 https://doi.org/10.1016/j.ijleo.2021.168542.
15. Self-powered and broadband flexible photodetectors based on vapor deposition grown antimony film Han Tang 1, Donglin Lu 1, Qianqi Zhou, Siwei Luo, Kai Huang , Zhenqing Li, Xiang Qi, Jianxin Zhong , Applied Surface Science Volume 571, 1 January 2022, 151335.
16. Investigation and fabrication of Cadmium Telluride (CdTe) single crystal as a photodetector by Bharati G. Valmik, M.P. Deshpande , Sandip V. Bhatt, Vasant, Sathe Hitesh kumar R.Bhoi, Piyush Rajput, S.H.Chaki, Physica B: Condensed Matter Volume 614, 1 August 2021, 413027 https://doi.org/10.1016/j.physb.2021.413027.

Topics relevant to "EMPLOYABILITY SKILLS": Dielectric materials, Quantum Mechanical concept, PWM pulse generation for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Pritam Keshari Sahoo
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3022	**Course Title: Fundamentals of Photonics** **Type of Course: Discipline Elective- General Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	A background in silicon photonics, fiber optics, or semiconductors is recommended, but not required. Proficiency in linear algebra and calculus will enhance understanding of design concepts. The course emphasizes on How to model photonic devices, working, analysis and design of photonic devices and also to create compact models for them . Additionally, this course will create a foundation for future courses such as advanced photonics.						
Anti-requisites	NIL						
Course Description	Photonic integrated circuit has evolved into a key technology with transformative impact on a wide variety of applications, ranging from high-speed data transmission to further quantum optics and optical computing.						
Course Objective	The objective of the course The objective of the course is to familiarize the learners with the concepts of Fundamentals of Photonics and attain is SKILL DEVELOPMENT of the student by using PARTICIPATIVE LEARNING techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: 1: Apply advanced techniques and tools of sensing and computation to solve multi-disciplinary challenges in industry and society. 2: Strong cognizance in the area of high-speed data transmission. 3: To learn how to develop photonic devices. 4: Evaluate the gap between theoretical basics and high-impact applications by combining a lecture with a hands-on design.						
Course Content:							
Module 1	Introduction and review	Quiz	Memory Recall based Quizzes	**8 sessions**			
Topics: Optical communications: short-reach, long-haul, and data centers communications. Economic drivers towards photonic integration. Interaction of optical waves with dielectric and metal interfaces. Boundary conditions, total internal reflection. Review of silicon PN-and PN-junctions. Junction diode static and transient characteristics.							
Module 2	Fundamentals of Silicon photonics	Assignment/Quiz	Theory	**7 sessions**			
Topics: Symmetric dielectric waveguides. Asymmetric dielectric waveguides. Rectangular waveguides. Computational methods for integrated photonics, design and fabrication of silicon waveguide structures. Waveguide loss, scattering, absorption, radiation.							
Module 3	Photonic systems	Assignment	Memory Recall based Quizzes	**7 sessions**			
Introduction to photonic systems for short-reach and long-haul optical communications. Modulation formats, receiver and transmitter characteristics, optical link budget, BER and penalties. Introduction to data center optical networks. Optical switching. Optical switches.							
Module 4	Optical Cavities	Assignment	Comprehension based Quizzes and assignments	**8 sessions**			
Fabry-Perot resonators, Examples of optical cavities, Cavity mode structure, Micro-ring and micro-disk resonators, Numerical analysis of the cavity modes, Waveguide-Cavity Coupling, Theory of							

coupling of a waveguide and a cavity, Critical Coupling and Add/Drop filters using waveguide-cavity coupling.

Targeted Application & Tools that can be used:

Tools: N.A

Project work/Assignment:

1. Design a project based on analysis, design and testing of the silicon photonic circuits.
2. Create a simple network model with multiple scenarios, collect statistics on network performance through the use of simulation tools, analyse statistics and draw conclusions on network performance.

Text Book(s):

1. S.L.Chuang, Physics of Photonic Devices, second edition, Wiley, New York, 2009.
2. B. Saleh and M.C. Teich, Fundamentals of Photonics, 2nd ed., Wiley, 2007.

References

1. G.P Agrawal, Fiber Optic Communication Systems, Wiley, ISBN 0470505117
2. R.G feller and U. Bapst. Wireless in-house communication via diffuse infrared radiation, SPIE Press
3. S. Hranilovic. Spectrally Efficient Signalling for Wireless Optical Intensity Channels. PhD thesis, Dept. of Elec. & Comp. Engineering, University of Toronto, 2003.

Online Resources & E-content(e-books, notes, ppts, video lectures etc.):

1. NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview
2. EDX - https://www.edx.org/course/silicon-photonics-design-fabrication-and-data
3. COURSERA - https://www.coursera.org/specializations/optical-engineering.
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

Research Papers

1. 1P. Qiao, G. Su, Y. Rao, C. J. Chang-Hasnain and S. L. Chuang, "Modeling of long-wavelength high contrast grating VCSELs and comparison with experiment," *CLEO: 2013*, 2013.**https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6833068&isnumber=6832912.**

2. Guan-Lin Su, Pengfei Qiao, C. -Y. Lu, D. Bimberg and S. L. Chuang, "Low-threshold dielectric-cavity microlasers," *2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications*, 2014, pp. 1-2. **https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6990118&isnumber=6988061**

3. Weik, M.H. (2000). integrated fiber optic communications system. In: Computer Science and Communications Dictionary. Springer.**https://doi.org/10.1007/1-4020-0613-6_9232**

4. Weik, M.H. (2000). fiber optic communications system. In: Computer Science and Communications Dictionary. Springer. **https://doi.org/10.1007/1-4020-0613-6_9221**

Topics relevant to "EMPLOYABILITY SKILLS": Development of Silicon photonics for developing Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Dr Balaji K A
Recommended by the Board of	BOS Meeting NO: 19th BOS held on 06/07/2024

Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3091**	**Course Title: Mathematical Physics** **Type of Course: Discipline Elective-General Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Sound knowledge of engineering mathematics including differential and integral calculus, linear algebra, vector calculus, numerical methods and probability theory					
Anti-requisites	**NIL**					
Course Description	The purpose of this course will be to understand and appreciate the symbiotic relationship that exists between mathematics and physics. The course combines studies in physics and mathematics to provide the learner with the tools required to understand the physical world and gain an introduction to advanced mathematical theory. This course will build a strong foundation for careers in logistics management, market research, medical or research analysis, finance, consulting, fluid dynamics, and electrodynamics.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	**On successful completion of this course the students shall be able to:** 6. Solve ordinary and partial differential equations. 7. Demonstrate the applications of partial differential equations encountered in physical problems. 8. Apply the concepts of Green's function in solving PDEs related to problems pertaining to electrical and mechanical engineering. 9. Analyze the concepts of complex calculus and functions in advanced formulation.					
Course Content:						
Module 1	**Ordinary and Partial Differential equations**	Assignment/Quiz	Problem Solving	**12 Classes**		
Topics: Ordinary Differential equations – Forbenius method, solution by inspection, change of dependent variables, change of independent variables, Partial Differential Equations - Separation of Variables in Spherical Coordinates, solving wave and heat equations, Bessel, Laplace and Legendre PDE, Hermite and Laguerre polynomials, Gauss's hypergeometric series						
Module 2	**Applications of partial differential equations in physics and engineering**	Assignment/Quiz	Simulation	**10 Classes**		
Topics: The diffusion equation – Fick's law, diffusion in one dimension, diffusion with drift, sedimentation, equation of motion of fluid element, Euler's Equation, Barotropic Flow, Bernoulli's						

Principle in Steady Flow, Irrotational Flow and the Velocity Potential, vorticity, flow of a viscous fluid, Navier-Stokes equation, Classical Electromagnetism, Maxwell's Field Equations, The Scalar and Vector Potentials, Gauge Invariance and Choice of Gauge, The Coulomb Gauge, Electrostatics, Magnetostatics, The Lorenz Gauge

Module 3	**Green's function**	Assignment	Simulation	**8 Classes**

Topics: Sturm-Liouville problem, Green's function in engineering, Green's function in closed form and series form, Green's identities, solution of PDEs using Green's functions – scalar Helmholtz equation (rectangular, cylindrical and spherical coordinates), dyadic Green's functions

Module 4	**Complex analysis**	Assignment	Problem Solving	**12 Classes**

Topics: Complex calculus - Riemann sphere, analytic functions, Cauchy-Riemann equations, power series as analytic functions, Cauchy's integral theorem, singularities, contour integration, Mobius transformation and applications of conformal mapping in electrostatics

Targeted Application & Tools that can be used:
This course will lay a foundation for further study in engineering and physics. The knowledge gained from this course will find applications in other courses like classical field theory, fluid dynamics, electrostatics, etc.
Professionally Used Software: Matlab/Mathematica

Project work/Assignment:

1. Case Studies: NA.
2. Book/Article review: NA
3. Presentation: The student will have to present a topic of his/her choice individually, where he/she has to demonstrate the solution of an engineering/physical problem using one of the techniques learned in this course.Assignment 1: Problems on Scalar Helmholtz equation. **Assignment 2:** Cauchy's integral theorem.

Text Book(s):

1. Gary N. Felder and Kenny M. Felder, "Mathematical Methods in Engineering and Physics",2nd edition, Wiley, 2016
2. James R. Kirkwood, "Mathematical Physics with Partial Differential Equations",1st edition, Academic Press, Elsevier, 2012
3. V. Balakrishnan, "Mathematical Physics: Applications and Problems",1st edition, Springer Nature; 2020

Reference(s):
Reference Book(s):

1. Derek Raine, "Mathematical Physics - An Introduction",1st Edition, Mercury Learning and Information, 2019
2. A. K. Ghatak, I. C. Goyal, S. J. Ch ua, "Mathematical Physics - Differential Equations and Transform Theory",1st Edition, Trinity Press, 2019

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Course on "Selected Topics in Mathematical Physics - NPTEL" by Prof. V. Balakrishnan, IIT Madras. https://nptel.ac.in/courses/115/106/115106086/
2. NPTEL Course on "Mathematical Physics-1", by Dr. Saurabh Basu, IIT Guwahati. https://nptel.ac.in/courses/115103036
3. https://presiuniv.knimbus.com/user#/home

E-content

1. V D Kupradze, "ON THE APPROXIMATE SOLUTION OF PROBLEMS IN MATHEMATICAL PHYSICS", Russian Mathematical Surveys, Volume 22, Number 2, pp:58. https://iopscience.iop.org/article/10.1070/RM1967v022n02ABEH001210/pdf
2. A A Samarskii and I V Fryazinov, "DIFFERENCE APPROXIMATION METHODS FOR PROBLEMS OF MATHEMATICAL PHYSICS", Russian Mathematical Surveys, Volume 31, Number 6, pp:179.

https://iopscience.iop.org/article/10.1070/RM1976v031n06ABEH001587/pdf
3. H. D. Alber & R. Leis, "Initial-boundary value and scattering problems in mathematical physics", Lecture Notes in Mathematics book series (LNM),volume 1357, pp:23-60. https://link.springer.com/chapter/10.1007/BFb0082861

Topics related to "FOUNDATION SKILLS": Ordinary Differential equations, change of dependent variables, Bessel, Laplace and Legendre PDE
Topics related to "SKILL DEVELOPMENT": Applications of partial differential equations in physics and engineering

Catalogue prepared by	Dr. Sumantra Chaudhuri
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3101	**Course Title:** Printed Circuit Board Design **Type of Course Discipline Elective-General Basket**		**L-T-P-C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Basic electronics concepts						
Anti-requisites	**NIL**						
Course Description	This course will teach teams of students how to design and fabricate PCB for prototyping as well as in Industrial Production environment. This will help students to innovate faster with electronics technology.						
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand basics of PCB designing. 2. Apply advance techniques, skills and modern tools for designing and fabrication of PCBs. 3. Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB. 4. Understand concepts of Packaging.						
Course Content:							
Module 1	Introduction	Quiz	Memory Recall based Quizzes	**7 session**			
Topics: Need for PCB, Types of PCBs Single and Multilayer, Technology: Plated Through Hole, Surface Mount, PCB Material, Electronic Component packaging, PCB Designing, Fabrication, Production, Electronic Design Automation Tools: Proprietary tools like Eagle, Ultiboard, Orcad and Opensource tools like KiCad, Design Issues: Transmission line, Cross talk and Thermal management.							
Module 2	PCB Design	Assignment / Quiz	Design and Simulation task	**12 session**			
Topics: Introduction to KiCad, Schematic entry / drawing, netlisting, layering, component foot print library selection & designing, design rules, component placing: Manual & automatic, track routing: automatic & manual, rules: track length, angle, joint & size, Autorouter setup. IPC standards for schematic, designing, material and documentation							
Module 3	PCB Prototyping and Production	Assignment	Analysis and Verification	**16 session**			
Topics: PCB Prototyping: CNC Machine, Photo-Lithography process, Screen Printing process and chemical etching. PCB Mass Manufacturing Process: Gerber Generation, CAM, panelization, cleaning, drilling, plating, screen printing, etching, automated optical inspection, tinning, solder resist, legend printing, PCB testing							
Module 4	PCB design for EMI/EMC		Case study	**10 session**			
Subsystem/PCB Placement in an enclosure, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Electronic waste; Printed circuit boards Recycling techniques,Introduction to Integrated Circuit Packaging and footprints, NEMA and IPC standards,.							

Targeted Application & Tools that can be used:

Application: Printed circuit board (PCB) design **brings your electronic circuits to life in the physical form**. Using layout software, the PCB design process combines component placement and routing to define electrical connectivity on a manufactured circuit board **The students will be able to find career opportunities in various domains such as:**

PCB design engineer
PCB layout engineer.
Application engineer technical support.
Professionally Used Software: Altium.,Fusion 360.,Altium 365,NI Multisim,Autodesk EAGLE, KiCad EDA,Ansys RedHawk.EasyEDA.

Project Work/Assignment:

1.Case Studies: At the end of the course students will be given a PCB-HISTORY * TYPES * APPLICATIONS * ADVANTAGES * DIS-ADVANTAGES * TOP PCBs MANUFACTURERS IN INDIA * MATERIALS USED IN MANUFACTURING PCBs * MANUFACTURING PROCESS * SOLDER RESIST * TEST * PROTECTION AND PACKAGING **as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. using PCB**

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment:

Assignment 1: Implement simple analog circuits using KiCad.

Assignment 2: Assignment Each student was assigned a unique schematic to be drafted using MultiSim's schematic capture feature. You should create an error-free net list, import it into the PCB feature of Ultiboard, then design a proper laid-out and routing. Designs should be no bigger than 6"x6"

Text book:

1. Printed circuit board design ,fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006

Reference(s):
Reference Book(s):
Online Resources (e-books, notes, ppts, video lectures etc.):

Jon Varteresian, Fabricating Printed Circuit Boards, Newnes, 2002

2. R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill 2001

3. Mark Madou, Fundamentals of Microfabrication, CRC Press, ISBN: 0-8493-9451-1

4. Elaine Rhodes, Developing Printed Circuit Assemblies: From Specifications to Mass Production, 2008 5. C. Robertson. PCB Designer´s Reference. Prentice Hall, 2003

6. C. Coombs, Printed Circuits Handbook, McGraw-Hill Professional, 6 edition, 2007

7. V. Shukla, Signal Integrity for PCB Designers, Reference Designer, 2009

8. D. Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, 2003

9. B. Archambeault, J. Dreuiawniak, PCB Design for Real-World EMI Control, Springer, 2002
10. RS Khandpur, Printed Circuit Board, Tata McGraw Hill Education Pvt Ltd., New Delhi
11. S D Mehta, Electronic Product Design Volume-I, S Chand Publications
12. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/
13. PCB Fabrication user guide page: http://www.wikihow.com/Create-Printed-Circuit-Boards , http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication/ , http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself
14. PCB Fabrication at home(video): https://www.youtube.com/watch?v=mv7Y0A9YeUc, https://www.youtube.com/watch?v=imQTCW1yWk

E-content:

1. Andres H. Rodriguez; Daniel J. Gonzalez; Mark C. Lesak " Design of a Printed Circuit Board (PCB) for Electrical Integration on the Agile Ground Robot (AGRO)." in 2020 IEEE MIT Undergraduate Research Technology Conference (URTC). https://ieeexplore.ieee.org/document/9668875.
2. Rémy Caillaud; Cyril Buttay; Roberto Mrad; Johan Le Leslé; Florent Morel; Nicolas Degrenne; Stefan M."Design, manufacturing and characterization of printed circuit board embedded inductors for power applications" in **2018 IEEE International Conference on Industrial Technology (ICIT).** https://ieeexplore.ieee.org/document/8352262
3. Ali Toprak; Ali Rifat Boynuegri "Printed Circuit Board Rapid Prototyping with Three-Dimensional Printer" in 2020 *4thInternational* Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) https://ieeexplore.ieee.org/document/9254998

4.https://presiuniv.knimbus.com/user#/home

Topics related to development of "FOUNDATION": Need for PCB, Types of PCBs Single and Multilayer, Technology
Topics related to development of "EMPLOYABILITY": PCB DESIGN
Topics related to development of "ENTREPRENEURSHIP": PCB Prototyping and Production
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": PCB design for EMI/EMC.
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Application of PCB design.

Catalogue prepared by	Ms Srilakshmi K H
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Signal Processing Basket

Course Code: ECE3028	**Course Title: Speech Signal Processing** **Type of Course: Discipline Elective-Signal Processing Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts like Energy, Magnitude, Zero Crossing rate, Autocorrelation function, pole zero analysis, DFT and some basic mathematical concepts.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce basic principle of speech production and perception, speech processing oriented to human-computer interaction, categorization of speech sounds based on the source-system. This course also develops speech recognition and verification models. The course offers a practical and theoretical understanding of how human speech can be processed by computers. The course deals with the details of algorithms, techniques and limitations of state of the art speech systems. The course involves quizzes and programming assignments using MATLAB based programming and using Goldwave and Audacity tools for speech analysis.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Speech Signal Processing to improve the learners' Employability Skills by using Participative Learning techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Understand the fundamental concepts of speech production 2) Discuss short time principles in digital speech processing to understand various parameters of speech. 3) Demonstrate the properties of speech in the context of "frequency domain analysis". 4) Analyze different types of speech processing and its applications.					
Course Content:						
Module 1	**Fundamentals of Human Speech Production**	Quiz	Memory Recall based Quizzes			**10 Sessions**
Topics: Introduction to Speech, The Mechanism of speech production, Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates						
Module 2	**Discrete time speech signals**	Assignment	Comprehension based Quizzes and assignments;			**10 Sessions**
Topics: Introduction, Time dependent processing of speech, short time energy and average magnitude, short time Average zero crossing rate, Speech vs. silence discrimination using Energy and Zero Crossings, Pitch period estimation using parallel processing approach						
Module 3	**Frequency domain methods for speech processing**	Assignment	Comprehension based Quizzes and assignments;			**10 Sessions**
Topics: Introduction, definitions and properties: Fourier Transforms interpretation and Z transform						

interpretation, sampling rates in time and frequency, filter bank Summation method for short time Synthesis, Spectral estimation of speech using the discrete Fourier Transform

Module 4	**The Cepstrum and Homomorphic Speech Processing**	Assignment	System Design Task and Analysis	**10 Sessions**

Topics:

Introduction, Homomorphic Systems for Convolution, Homomorphic Analysis of the Speech Model, Computing the Short-Time Cepstrum and Complex Cepstrum of Speech, Homomorphic Filtering of Natural Speech, Cepstrum Analysis of All Pole Models, Cepstrum Distance Measures. Applications of speech processing.

Targeted Application & Tools that can be used:

DSP applications include audio and speech processing, sonar, radar and other sensor array processing, Speech coding, Speech recognition, Speech verification\identification, Speech enhancement, Speech synthesis Other Applications of speech processing: Human computer interfaces (e.g. speech I/O) Telecommunication (e.g. speech enhancement, translation)

Professionally Used Software: Matlab, Goldwave, Audacity, Kaldi**.**

Text Book(s):

1. Lawrance Rabiner and Ronald Schafer, "Digital Speech Processing: Theory and Applications", Pearson, 1st Edition
2. Theory and Applications of Digital Speech Processing 2011 . Rabiner and Schafer, Pearson Education,2

Reference Book(s)

1. Thomas F. Quatieri, "Discrete Time Speech Signal Processing: Principles and Practice", Pearson, 2002

2. S. K. Mitra, "Digital Signal Processing: A computer-Based Approach", Tata McGraw Hill, 4th Edition

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Digital Speech Processing By Prof. Shyamal Kumar Das Mandal (IIT Kharagpur) - NPTEL - https://onlinecourses.nptel.ac.in/noc22_ee117/preview
2. Digital Speech Processing courses on Udemy - https://www.udemy.com/course/digital-speech-processing/
3. Build automated speech systems with Azure Cognitive Services by Microsoft on Coursera - https://www.coursera.org/projects/build-automated-speech-systems-with-azure-cognitive-services
4. Automatic Speech Recognition e-book https://link.springer.com/book/10.1007/978-1-4471-5779-3

E-content:

1. G. Potamianos, "Audio-visual automatic speech recognition and related bimodal speech technologies: A review of the state-of-the-art and open problems," *2009 IEEE Workshop on Automatic Speech Recognition & Understanding*, 2009, pp. 22-22, doi: 10.1109/ASRU.2009.5373530. - https://ieeexplore.ieee.org/document/5373530
2. M. Wolfel, "Predicted walk with correlation in particle filter speech feature enhancement for robust automatic speech recognition," *2008 IEEE International Conference on Acoustics, Speech and Signal Processing*, 2008, pp. 4705-4708, doi: 10.1109/ICASSP.2008.4518707. - https://ieeexplore.ieee.org/document/4518707
3. R. King, "New challenges in automatic speech recognition and speech understanding," *TENCON '97 Brisbane - Australia. Proceedings of IEEE TENCON '97. IEEE Region 10 Annual Conference. Speech and Image Technologies for Computing and Telecommunications (Cat. No.97CH36162)*, 1997, pp. 287 vol.1-, doi: 10.1109/TENCON.1997.647313. - https://ieeexplore.ieee.org/document/647313
4. J. Droppo and A. Acero, "Experimenting with a global decision tree for state clustering in automatic speech recognition systems," 2009 IEEE International Conference on Acoustics,

	Speech and Signal Processing, 2009, pp. 4437-4440, doi: 10.1109/ICASSP.2009.4960614. - https://ieeexplore.ieee.org/document/4960614
Topics relevant to "EMPLOYABILITY SKILLS": Speech vs. silence discrimination using Energy and Zero Crossings, Pitch period estimation using parallel processing approach, Fourier Transforms interpretation and Z transform interpretation of speech signal, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Ms. Aruna M Ms. Anupama Sindgi
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE3029</td><td colspan="2">Course Title: Digital Image Processing

Type of Course: Discipline Elective-Signal Processing Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="7">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">The various signal processing operations are used as a tool for variety of basic image processing operation. Since DIP is a subfield of signal processing, a good knowledge ofFourier Transform and its properties would help in image analysis. The course needs a fair knowledge of Mathematics and Computational logic.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">The purpose of this course is to enable the students to appreciate the fundamental concepts of Digital Image Processing. The course is both conceptual and analytical which imparts knowledge on designing algorithms for real-world applications. The course also enhances the programming abilities through assignments. This course will help the students to get jobs in various areas where Image processing is needed, like the film industry, news channels, video mixing, social media platforms, YouTube, animation industry and so on.</td></tr>
<tr><td>Course objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of Digital Image Processing to improve the learners' <u>Employability Skills</u> by using <u>Experiential Learning</u> techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:
1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms
3. Evaluate the techniques for image enhancement and image restoration
4. Categorize various compression techniques.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals Of Image Processing</td><td>Application Assignment</td><td colspan="2">Data Analysis task</td><td>10 session</td></tr>
<tr><td colspan="8">Topics:
Fundamentals Of Image Processing: Introduction – Steps in image processing systems – Image Sensing and acquisition – Image formation Model-Sampling and Quantization - Representation of Digital Images –Pixel relationships –Mathematical tools used in Digital Image processing.</td></tr>
<tr><td>Module 2</td><td colspan="2">Image Enhancement</td><td>Assignment</td><td colspan="2">Simulation and data analysis task</td><td>12 session</td></tr>
<tr><td colspan="8">Topics:
Image Enhancement: Introduction to two dimensional orthogonal & unitary transforms- Two dimensional discrete Fourier transform - Properties of unitary transforms- Spatial Domain Gray level Transformations – Histogram processing – Image enhancement in the Frequency Domain filters – Smoothing and sharpening filters – Homomorphic Filtering</td></tr>
</table>

Module 3	**Image Analysis**	Assignment	Data Collection and Analysis	**10session**
Topics: Image Analysis: Image restoration process- Fundamentals of Image Compression - Image Compression Model-Huffman coding. Fundamentals of Image Segmentation - Point, Line and Edge detection				
Module 4	**Color And Morphological Image Processing**	Assignment	Simulation/Data Analysis	**07 classes**
Topics: Introduction –Basics and fundamentals of Color Image Processing and Color models-Pseudo color Image Processing-Wavelets and Multiresolution Processing - Image Pyramids-Subband Coding- Introduction to Morphological Image Processing. Ethical practices to be observed while doing Image processing.				

List of Laboratory Tasks:

Experiment No 1: Implement a program to display color image using read and write operation and extract its attributes.

Level 1: If we read given color image using imread () function, we get 3-D matrix. Write a program separate color image into three separate R,G,B planes. What the key attributes of the image file.

Level 2: Create image of size 512x512 black square using monochrome, 256 gray-level using paint or any other relevant software and save it file name "black.bmp" Read and display image using MATLAB commands.

Experiment No. 2: Apply Arithmetic operations on a given image.

Level 1: Image subtraction is used Image enhancement of difference between images. Write a program to obtain the difference between images captured at different time period.

Level 2: Consider a digital Dental images to extract Region of Interest using (ROI) masking operation to isolate the teeth with fittings . Write Program to take out the ROI.

Experiment No. 3: Apply Logical operation on a given image.

Level 1: Prepare any two images of size 256 x 256 in paint. Save it in JPEG format 256 gray levels. Perform logical operations (AND, OR, NOT, NAND, NOR, XOR) between two images. Write program and paste your
Results.

Level 2: Digital watermark is a pattern of bits inserted into a digital image, audio or video file's copywrited information (author, rights etc.). Write a program to demonstrate watermarking using EX-OR operation.

Experiment No. 4: Program to compute the histogram of an input image and perform histogram equalization.

Level 1: Consider a gray scale image, find histogram value and display histograph of a grayscale. Write a program to perform histogram equalization on this image and scale the intensity to 1:20. Compare your results

Level 2: Take your own photograph in dark area. Improve its appearance using histogram equalization.

Experiment No. 5: Implement geometric transformation (Translation, Scaling, Rotation, Shrinking, Zooming)
on a given image:

Level 1: Resize the image of your choice by two scaling factors: ½ and 2. Apply Zoom-In (the Looking-Glass icon in the Figure window) on areas with details and observe the differences between the 2 interpolation methods. Save these zoom-ins and add them to your final report.

Level 2: A computer graphics system requires the user to construct everything directly into a single scene. A chocolate bar image is been built in a convenient place and to a convenient size which are as follows (2,-2) (2, 2) (-2,2) (-2,-2). Because of the requirements of a scene, it is required to first moved to a desired position by (3, 2) and then scaled to be bigger by factor 3.

Experiment No. 6: Perform Image Restoration using filters.

Level1: Explain the differences between Matlab commands randn and imnoise(I,'gaussian',...). Try to understand how the imnoise (I,'gaussian',) command utilizes a randn command. Hint: you may find the command type useful.

Level 2: John at age 65years finds his college day group photo in his old album. He wanted to repair his faded photo for preserving them for future generation. Determine and implement the correct Image Restoration technique toimprovise the appearance of the image.

Experiment No. 7: Implement Image Frequency Domain Filtering

(a) Apply FFT on given image

(b) Perform low pass and high pass filtering in frequency domain

(c) Apply IFFT to reconstruct image

Level 1: Consider the given Gray Scale Image. Write a Program to perform Gaussian Low Pass and High Pass filtering. Tabulate the Results.
Level 2: Figure shows a sample of text of poor resolution. Although human fill gaps visually without difficult, a machine recognition system has real difficulties reading broken characters. Design filter to repair the character and Implement using Matlab program.

Experiment No. 8: Implement Image Morphological Operations erosion and dilation.

Level1: Given an Image A and it's structuring element. Compute the Output Image for Morphological operation $A^c \theta B$. Implement using Matlab code.

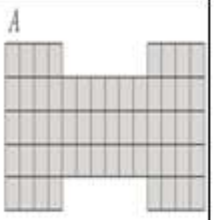
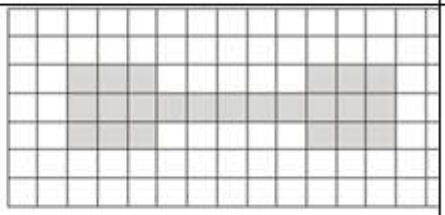
A

0	0	0	0	0	0
0	0	1	1	0	0
0	1	1	1	1	0
0	0	1	1	0	0
0	0	0	0	0	0

B

1
1
1

Level 2: With reference to the image shown, give the structuring element and morphological operation(s) that produces each of the results shown .Show the origin of each structuring element clearly.

Input Image A	Structuring Element Origin	Output Image	Morphological Operation
			

Targeted Application & Tools that can be used:

Applications of Digital Image Processing: Acquisition of instant information has become possible because of the advancements taking place in the domain of the internet. Image processing is already being used by a diverse range of companies and it holds a huge potential of wide adoption in the future. The students will be able to find career opportunities in various domains such as:

- **Image sharpening and restoration.**
- **Medical field.**
- **Remote sensing.**
- **Transmission and encoding.**
- **Machine/Robot vision.**
- **Color processing.**
- **Pattern recognition.**
- **Video processing.**

Professionally Used Software: MATLAB is an extraordinary tool for making image processing applications and is generally utilized in research as it permits quick prototyping

Test Book(s):

1. Gonzalez, R. C. & R. E. Woods, "Digital Image Processing", Pearson Education, 3rd edition. 2009

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on "Digital Image Professing" by Prof. Dr. P K Biswas, IIT Kharagapur. https://freevideolectures.com/course/2316/digital-image-processing-iit-kharagpur
2. https://www.coursera.org/learn/digital
3. https://nptel.ac.in/courses/117/105/117105135/

Reference(s):

Reference Book(s):

1. Y. Wang, J. Ostermann, and Y.Q.Zhang, "Video Processing and Communications,", Prentice Hall, First Edition
2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach," Prentice Hall; First Edition
3. Richard Hartley, Andrew Zisserman, "Multiple View Geometry in Computer Vision," Cambridge University Press, Second Edition

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Online notes :- https://web.eecs.umich.edu/~justincj/teaching/eecs442/WI2020/syllabus.html#
2. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc21_ee23/preview
3. Online ppts :- http://www.wu.ece.ufl.edu/courses/eee6512f16/index.htm
4. Online ppts:https://staff.fnwi.uva.nl/r.vandenboomgaard/IPCV20172018/20172018/syllabus.html

E-content:

1. K. Rasool Reddy; K. Hari Priya; N. Neelima , " Object Detection and Tracking -- A Survey 2015 International Conference on Computational Intelligence and Communication Networks (CICN) https://ieeexplore.ieee.org/document/7546127
2. Hammad Naeem; Jawad Ahmad; Muhammad Tayyab ," Real-time object detection and tracking", IEEE International Conference on Multi Topic-INIMC, December 2013 https://ieeexplore.ieee.org/document/6731341
3. Vijeta Sharma; Manjari Gupta; Ajai Kumar; Deepti Mishra , " Video Processing Using Deep Learning Techniques: A Systematic Literature Review ", IEEE Access , VOL. 9 https://ieeexplore.ieee.org/document/7322178
4. Sahar Movaghati, Alireza Moghaddamjoo, Ahad Tavakoli," Road Extraction From Satellite Images Using Particle Filtering and Extended Kalman Filtering IEEE Transactions on Geoscience and Remote Sensing , VOL. 48, issue.7 https://ieeexplore.ieee.org/document/5439693

Topics relevant to "EMPLOYABILITY SKILLS": Representation of Digital Images, Image operation, Image segmentation, Image Analysis, Color And Morphological Image Processing, for developing Employability Skills through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr K BhanuRekha, Annapurna.H.S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3030	**Course Title: Fuzzy Logic and its Engineering Applications** **Type of Course: : Discipline Elective- Signal Processing Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	**Fuzzy Logic is an advanced topic, so the students opting for this subject should have preliminary knowledge of Set Theory, Logic, and Engineering Mathematics**						
Anti-requisites	**NIL**						
Course Description	The course is specially designed for candidates dealing with electrical, electronics, and communications engineering. The candidates can engage in the fuzzy systems theory concepts and gain an in-depth understanding of its usage in multiple domains. The course is designed to give a solid grounding of fundamental concepts of fuzzy logic and its applications. It will cover the basics of fuzzy set theory and presents different problems where one can apply this concept. In this course, students will learn how to implement fuzzy logic for problems involving uncertainties and vagueness. This course will act as a foundation course for the researchers working in different areas of science and engineering.						
Course Description	**The objective of the course is to familiarize the learners with the concepts of Fuzzy Logic and its Engineering Applications to improve the learners' Employability Skills by using Participative Learning techniques.**						
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Explain** the concept of fuzzy logic and fuzzy system theory. 2. **Discuss** the application of fuzzy system theory in artificial intelligence. 3. **Understand** various issues in fuzzy system theory. 4. **Illustrate** the application of fuzzy system on real time problem.						
Course Content:							
Module 1	**Introduction to Fuzzy Sets Theory**	Quiz	Memory Recall based Quizzes	**10 Sessions**			
Topics: **Introduction, The Utility of Fuzzy Systems, Uncertainty and Information, Fuzzy sets and membership, Chance Versus Fuzziness, Fuzzy Set Operations, Properties of Fuzzy Set Operations**							
Module 2	**Membership Functions, Fuzzification and De-fuzzifications**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB	**10 Sessions**			
Topics: **Features of Membership function, Various Forms, Fuzzification, De-fuzzification to Crisp Sets, De-fuzzification to Scalars, Fuzzy(Rule-based) Systems**							
Module 3	**Fuzzy Classification**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB	**10 Sessions**			
Topics: **Classification by Equivalence Relations, Crisp Analysis, c-Means Clustering, Fuzzy c-means clustering, Classification metric, Hardening the Fuzzy c-Partition**							

Module 4	**Fuzzy Control System**	Assignment	System Design Task and Analysis	**10 Sessions**

Topics:

Control System Design Problem, Control(Decision) Surface, Assumption in a fuzzy control system design, Simple Fuzzy logic controllers, Fuzzy engineering process control, Fuzzy statistical process control

Targeted Application & Tools that can be used:

Fuzzy logic based speech recognition, Fuzzy image search, Handwriting recognition, Fuzzy set modeling of decision making, Trainable fuzzy systems for idle speed control, Control of automatic exposure in video cameras, Humidity control in a clean room, Air conditioning systems, Washing machine timing, Microwave ovens, Vacuum cleaners, Altitude control of spacecraft, Satellite altitude control, Flow and mixture regulation in aircraft deicing vehicles, Decision-making support systems

Professionally Used Software: MATLAB

Text Book(s):

1. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley

Reference Book(s)

1. George J.KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, New Delhi,1995
2. S.Rajasekaran, G.A.Vijayalakshmi - Neural Networks and Fuzzy logic and Genetic Algorithms, Synthesis and Applications, PHI, New Delhi,2003.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Fuzzy Sets, Logic and Systems & Applications By Prof. Nishchal Kumar Verma, IIT Kanpur (NPTEL)- https://onlinecourses.nptel.ac.in/noc20_ee03/preview
2. A Beginner's course on Fuzzy Logic and it's Application (Udemy)- https://www.udemy.com/course/fuzzylogic/
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley E-book http://home.iitk.ac.in/~avrs/ManyValuedLogic/FuzzyLogicforEngineers.pdf
4. E-book "Fuzzy Logic with Engineering Applications", http://home.iitk.ac.in/~avrs/ManyValuedLogic/FuzzyLogicforEngineers.pdf
5. E-book "Fuzzy logic: a practical approach" , https://books.google.co.in/books?hl=en&lr=&id=3jGjBQAAQBAJ&oi=fnd&pg=PP1&dq=fuzzy+logic&ots=m2Jb2THX_r&sig=XaRwJHUguly1M8OFqXGAN02knTo&redir_esc=y#v=onepage&q=fuzzy%20logic&f=false
6. An Introduction to Fuzzy Logic Applications in Intelligent Systems https://books.google.co.in/books?hl=en&lr=&id=xbDSBwAAQBAJ&oi=fnd&pg=PA1&dq=ebook+fuzzy+logic&ots=ObXPuLUPEs&sig=cH4Wn_n9RA90TfOQH14ThtwM-3I#v=onepage&q=ebook%20fuzzy%20logic&f=false
7. E-content on Fuzzy Logic https://www.geeksforgeeks.org/fuzzy-logic-introduction/
8. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Bastian, S. Tano, T. Oyama and T. Arnould, "FATE: fuzzy logic automatic transmission expert system," *Proceedings of 1995 IEEE International Conference on Fuzzy Systems.*, 1995, pp. 5-6 vol.5, doi: 10.1109/FUZZY.1995.410015. https://ieeexplore.ieee.org/document/410015
2. Bastian, "Influencing the nonlinearity at the transition between fuzzy logic rules," *Proceedings of 1995 IEEE International Conference on Fuzzy Systems.*, 1995, pp. 1413-1418 vol.3, doi: 10.1109/FUZZY.1995.409865. https://ieeexplore.ieee.org/document/409865
3. C. Wong, "Realization of linear defuzzified output via mixed fuzzy logics," *[Proceedings 1993] Second IEEE International Conference on Fuzzy Systems*, 1993, pp. 1167-1172 vol.2, doi: 10.1109/FUZZY.1993.327349. https://ieeexplore.ieee.org/document/327349
4. R. L. de Mantaras and L. Godo, "From fuzzy logic to fuzzy truth-valued logic for expert systems: a survey," *[Proceedings 1993] Second IEEE International Conference on Fuzzy Systems*, 1993, pp. 750-755 vol.2, doi: 10.1109/FUZZY.1993.327536.

https://ieeexplore.ieee.org/document/327536	
Topics relevant to "EMPLOYABILITY SKILLS": Fuzzy Classification, Machine learning using Fuzzy Logic and Pattern Recognition, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Arvind Kumar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3031	**Course Title: Applications of Deep Learning** **Type of Course Discipline Elective- Signal Processing Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of statistics, algebra and matrix operations					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to enable the students to understand the theoretical concepts, algorithms and methodologies of Neural Networks, Deep Neural Networks, CNN, etc. The course also demonstrates the use of Python / MATLAB / SCILAB programming to develop classification applications using deep neural networks.**					
Course Objective	**The objective of the course is to familiarize the learners with the concepts of Applications of Deep Learning designed to improve the learner's Employability Skills by using Participative Learning Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Describe** the basics of deep neural networks 2) **Understand** the architecture of Convolutional Neural Layer 3) **Illustrate** variants of Convolutional Neural Layer such as RNN, GAN 4) **Apply** the deep learning concepts in real life scenarios					
Course Content:						
Module 1	**Fundamentals of Deep Learning**	Quiz	Memory Recall based Quizzes	**12 session**		
Topics: The Perceptron - History, Discovery, and Theory, Multilayer Perceptron, Activation Functions: RELU, LRELU, ERELU Back-propagation algorithm and its variants, Width and Depth of Neural Networks, Curse of Dimensionality. Loss function, Optimization Techniques, Stochastic gradient decent						
Module 2	**Deep Learning Architecture**	Assignment / Quiz	Programming task	**12 session**		
Topics: Introduction to Deep Learning, Comparison - Machine Learning and Deep Learning, Architectural Overview of CNN, Layers, Filters, various performance metrics for CNN, Parameter sharing, Regularization, Concept of Transfer learning, Unsupervised Training of Neural Networks, Ethical considerations while developing Deep Learning Models						
Module 3	**Variants of CNN**	Assignment	Memory Recall based Quizzes	**10 session**		

Topics:
Variants of CNN: LeNet, AlexNet, GoogleNet, ResNet, Highway Networks, PolyNet, YOLO, VGG, Inception, BLSTM, Deep Belief Networks.

Module 4	**Applications of Deep Learning**	Assignment	Programming task	**09 session**

Topics:
Deep Learning applications: Image Processing- Segmentation, Classification, object detection, Case studies from medical image processing, object detection, agricultural applications etc.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Data analytics, Computer Vision - Image & Video Processing, Speech Recognition, Automatic machine translation, object detection etc.
Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox

Text Book(s):

13. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 1st Edition

Reference(s):
Reference Book(s):

9. James Loy "Explore neural networks with Python", Packt Publisher,1st Edition
10. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 1st Edition
11. Seth Weidman "Deep Learning from Scratch ", O'Reilly Media, 1st Edition
12. Francois Chollet "Deep Learning with Python", Manning Publications, 2nd Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Free online self-paced course :- https://open.cs.uwaterloo.ca/python-from-scratch/
2. Online notes :- https://open.cs.uwaterloo.ca/language-independent-lessons/
3. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106106201/L01.html
4. Online ppts :- https://cs.uwaterloo.ca/~mli/Deep-Learning-2017-Lecture5CNN.ppt
5. Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt
6. https://presiuniv.knimbus.com/user#/home

E-content:

1. Sergiu Oprea , Pablo Martinez-Gonzalez, Alberto Garcia-Garcia , John Alejandro Castro-Vargas, Sergio Orts-Escolano , Jose Garcia-Rodriguez , and Antonis Argyros, (2022, June). A Review on Deep Learning Techniques for Video Prediction. IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 44, NO. 6 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9294028
2. Qin Zou , Member, IEEE, Lihao Ni , Tong Zhang , and Qian Wang, "Deep Learning Based Feature Selection for Remote Sensing Scene Classification". In IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 12, NO. 11, NOVEMBER 2015. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7272047
3. Tsung-Han Chan, Kui Jia, Shenghua Gao, Jiwen Lu, Zinan Zeng, and Yi Ma, " PCANet: A Simple Deep Learning Baseline for Image Classification?", in IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 24, NO. 12, DECEMBER 2015 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7234886
4. Dionysis Goularas; Sani Kamis, "Evaluation of Deep Learning Techniques in Sentiment Analysis from Twitter Data" 2019, *International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*. https://ieeexplore.ieee.org/xpl/conhome/8870906/proceeding

Topics relevant to "EMPLOYABILITY SKILLS": CNN, RNN, Applications of Deep Learning, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3032**	**Course Title: Multimedia Signal Processing** **Type of Course: Discipline Elective- Signal Processing Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	A fair knowledge in digital signal processing and basic concepts of frequency transformations is desirable.						
Anti-requisites	**NIL**						
Course Description	This is an undergraduate level course that deals multimedia presentations (text, graphics, speech, audio, image, video) and their standards for coding, processing and compression. The subject shall provide an introduction to our perception of speech, audio, music, image and video to be able to understand advanced techniques, algorithms and concepts for digital processing of multimedia presentations. The course enables to know the principles and technologies of several important standards and their typical application scenarios.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Multimedia Signal Processing to improve the learner's Employability Skills by using Participative Learning Methodologies.						
Course Outcomes	On successful completion of this course the students shall be able to: 1) Discuss the fundamentals behind multimedia signal processing and compression. (Comprehension) 2) Explain the basic principles behind existing multimedia compression and communication standards. (Comprehension) 3) Apply the acquired knowledge to specific multimedia related problems and projects at work. (Application)						
Course Content:							
Module 1	Basic Digital Signal Processing	Assignment	Programming Task, Data Analysis task	**12 classes**			
Topics: Digital Processing Basics, Multimedia Processing and Communications, Compression and Networking as Cornerstones, Information Theory Basics, Lossless Source Coding, Huffman/arithmetic Codes, LZW, Text/graphics Compression, Quantization (scalar/vector). Ethical practices to be observed while using multimedia techniques.							
Module 2	Model Based Signal Processing	Assignment	Programming Task, Data Analysis task	**10 classes**			
Topics: Waveform, Transform, Model-based Coding, Performance Criteria, Perception, Human Visual System Models, Still Image Compression, JPEG, JPEG2000, Wavelet/Sub-band/Fractal, Perceptually-based Coders, 2 nd Generation Image Coding							
Module 3	Multimedia Communication Standards	Project	Programming Task, Data Analysis task	**11 classes**			
Topics: Audio Compression, MPEG-1/2, Dolby AC-2 and AC-3, Compression of Stereo and Surround Sound, Video Compression Basics, Overview of Multimedia Communication Standards H.323 and H.324, Video Compression Standards H.261, H.263, Video Compression Standards MPEG-1, MPEG-2, and HDTV, MPEG-4, MPEG-7, Multimedia Transmission, Error Resilience and Concealment, Multimedia over IP							
Module 4	Applications of DSP to	Assignment	Programming Task, Data Analysis task	**12 classes**			

	Multimedia			

Topics:
Music Signal Processing and Auditory Perception, Speech Processing, Acoustic Theory of Speech-The Source–filter Model, Speech Models and Features, Speech Enhancement, Echo Cancellation

Textbook(s):
1. Saeed V. Vaseghi, "Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications", Wiley.

References:
1. Ralf Steinmetz and Klara Nahrstedt, "Multimedia Systems", Springer

2. Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", John Wiley

Online Resources (e-books, notes, ppts, video lectures etc.):
1. Multimedia Signal Processing | University of Illinois
https://courses.engr.illinois.edu/ece417/fa2020/
2. Multimedia Signal Processing | Norwegian University of Science and Technology
https://www.ntnu.edu/studies/courses/TTT4135

Other Resources:

Presidency University Library Link

https://presiuniv.knimbus.com/user#/home

1. Efficient and Low-Complexity Surveillance Video Compression Using Backward-Channel Aware Wyner-Ziv Video Coding, IEEE Transactions on Circuits and Systems for Video Technology (Volume: 19, Issue: 4, April 2009)

https://ieeexplore.ieee.org/document/4801602

2. Sparse Music Representation With Source-Specific Dictionaries and Its Application to Signal Separation, IEEE Transactions on Audio, Speech, and Language Processing (Volume: 19, Issue: 2, February 2011)

https://ieeexplore.ieee.org/document/5444999

Topics relevant to "EMPLOYABILITY SKILLS": Audio and video compression Standards, Digital Processing Basics for Multimedia Processing and Communications; Audio and Video Compression Basics, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3033**	**Course Title: Adaptive Signal Processing** **Type of Course: Discipline Elective- Signal Processing Basket**		**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Digital Signal Processing, Signal and Systems					
Anti-requisites	**NIL**					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Adaptive Signal Processing to improve the learner's Employability Skills of student by using Participative Learning techniques					
Course Description	The course aims to develop a mathematical theory of linear adaptive filters. The course discusses the adaptation techniques of the filter to achieve the desired output. Such adaptive algorithms are frequently encountered in many signal processing and machine learning algorithms. The adaptive signal processing course will be aided by simulations, which will enable the students to validate their theoretical findings.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Recognize the importance of signal processing in non-stationary environment. 2. Discuss the role of adaptive signal processing in communication systems. 3. Apply the various mathematical models to adaptive signal processing. **4.** Use of Weiner filter for given applications.					
Course Content:						
Module 1	Introduction/Stationary Processes and Model	Assignment/QUIZ	Memory Recall based quiz	**10 Sessions**		
Topics: INTRODUCTION: The filtering problem, Adaptive filters, linear filter structures, approaches to the development of linear adaptive filter algorithms, real and complex forms of adaptive filters, nonlinear adaptive filters, Applications. STATIONARY PROCESSES AND MODELS: Partial characterization of a discrete time stochastic process, mean ergodic theorem, correlation matrix, correlation matrix of sine wave plus noise, stochastic models, Wold decomposition, asymptotic stationarity of an auto regressive process. Yule-Walker equations						
Module 2	WIENER FILTERS	Assignment	Simulation task	**10 Sessions**		
Topics: WIENER FILTERS: Linear optimum filtering problem statement, principle of orthogonality, minimum mean squared error, Wiener Hopf equations, error performance surface. Channel equalization. Linearly constrained minimum variance filter, generalized side lobe cancellers**.**						
Module 3	Linear Prediction	Assignment	Simulation task	**10 Sessions**		
Topics: LINEAR PREDICTION: Forward Linear Prediction, backward Linear Prediction, Levinson-Durbin algorithm, properties of prediction error filters, Schur-Cohntest, auto regressive modeling of a stationary stochastic process. Method of steepest descent: Steepest descent algorithm, stability of the Steepest descent algorithm.						
Module 4	Applications of Adaptive signal processing	Assignment	Simulation task	**10 Sessions**		

Topics:
Adaptive modeling of a multi-path communication channel, adaptive model in geophysical exploration, Inverse modeling, Adaptive interference canceling: applications in Bio-signal processing.

Targeted Application & Tools that can be used:

Application Area includes all modern electronic devices (Music System, cellular phones, computers, digital cameras, high-definition smart televisions, Home Automation, Communication systems).

Tools that can be used: Signal processing tool box in MATLAB

Text Book(s):

1. Simon Haykin, " Adaptive Filter Theory", Pearson Education, 2003
2. Ali H. Sayed, Fundamentals of Adaptive Filtering, John Wiley, 2003

References

1. Bernard Widrow and Samuel D. Stearns, "Adaptive Signal Processing", Person Education, 2005.
2. John R. Treichler, C. Richard Johnson, Michael G. Larimore, "Theory and Design of Adaptive Filters", Prentice-Hall of India, 2002
3. S. Thomas Alexander, " Adaptive Signal Processing - Theory and Application", Springer-Verlag.
4. James V. Candy, Signal Processing: A Modern Approach, McGraw-Hill, International Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on "Adaptive Signal Processing" by Prof. Mrityunjoy Chakraborty, IIT KGP https://nptel.ac.in/courses/117105075
2. **Presidency University Library Link :-** https://presiuniv.knimbus.com/user#/home

E-content:

1. D.Morgan, "Adaptive signal processing" IEEE Trans. on Acoustics, Speech, and Signal Processing Vol 34, (4) 1986) **DOI:** 10.1109/TASSP.1986.1164869.
2. Alexander Voznesensky; Dmitrii Kaplun, "Adaptive Signal Processing Algorithms Based on EMD and ITD", IEEE Access (Volume: 7), **DOI:** 10.1109/ACCESS.2019.2956077.
3. B. Widrow; E. Walach Adaptive signal processing for adaptive control", **DOI:** 10.1109/ICASSP.1984.1172527.
4. Alexander Voznesensky; Dmitrii Kaplun, " Adaptive Signal Processing Algorithms Based on
5. EMD and ITD", IEEE Access Vol 7,2019 DOI: 10.1109/ACCESS.2019.2956077

Topics relevant to "EMPLOYABILITY SKILLS": WIENER FILTERS, Linear optimum filtering problem statement, Adaptive filters, Channel equalization, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr Dharmesh Kumar Srivastava
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3034	**Course Title: Bio-Medical Instrumentation** **Type of Course: : Discipline Elective- Signal Processing Basket**		**L- T-P- C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	[1] Linear Integrated Circuits, 2] Measuring Instruments and Sensors						
Anti-requisites	NIL						
Course Description	The purpose of this course is to enable the students to appreciate the need for Biomedical Instrumentation and Role of engineers in biomedical field. The course is conceptual in nature which allows the students to understand the application of various engineering concepts used in biomedical for diagnosis, treatment and prevention of diseases.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Bio-Medical Instrumentation and to improve the Employability Skills of student by using Participative Learning techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: 1) Summarize the components of biomedical Instrumentation and types of transducers used in BMI 2) Explain the principle of operation of the instruments used in Patient monitoring system and diagnosis. 3) Describe the concept of Electrocardiography, Electroencephalography, Electromyography and Electrooculography. 4) Discuss Modern imaging system used in BMI						
Course Content:							
Module 1	Introduction to Biomedical Instrumentation system	Assignment	A short note on instruments used in medical field for diagnosis, treatment and prevention of diseases				**08 Sessions**
Topics: Role of Technology in Medicine, Physiological Systems of the Body, Basic Medical Instrumentation System, Wireless Connectivity in Medical Instruments, Classification of Transducers, Optical Fibre Sensors, Biosensors, Smart Sensors, A basic recording system, Types of preamplifiers. Basic components of BMI systems, Classification of Transducers, Potentiometric transducer, variable capacitance, variable inductance, Piezo-electric Transducer, Strain gauge pressure transducer, Thermocouple, Thermistor, A basic recording system, General consideration for signal conditioners, Types of preamplifiers, differential, instrumentation amplifiers, isolation amplifier, chopper amplifiers. Biotelemetry							
Module 2	Patient Monitoring System	Case Study	Any one state of art patient monitoring systems				**09 Sessions**
Topics: Introduction to patient monitoring system, Types of patient monitoring system, Blood pressure measurement: Direct and Indirect method of blood pressure measurement, Phonocardiograph (PCG) for heart sound measurement, Blood Flow meter: Electromagnetic blood flow meters, Ultrasound, Dye dilution, thermal dilution method etc. Spirometer for lung volume and lung capacity measurement. Pulse rate measurement using IR principle.							
Module 3	Bioelectric Recorders	Assignment	Different types of electrodes, its features and specific application				**10 Sessions**

Topics:
Origin of bioelectric signals, polarization, depolarization, hyperpolarization. Propagation of bioelectric potentials. Electrode tissue interface, surface and deep-seated Electrodes. ECG: Function of heart, conduction path way, placement of electrodes, lead configurations. Block Diagram of an Electrocardiograph. EEG: Introduction to EEG, 10-20 system of placement of electrodes, Block Diagram of Electroencephalograph, EMG: Introduction to EMG, Block Diagram of EMG recording, Introduction to EOG.

Module 4	Modern Imaging System	Case study	Trends and recent research projects based on medical images	**8 Sessions**

Topics:
Introduction to medical imaging, Methods of Monitoring Foetal Heart Rate, Monitoring Labour Activity, Oximeters, Blood Flow Measurement, Methods of blood Cell Counting, Safety Codes for Electromedical Equipment,
Introduction to medical imaging, Basics of diagnostics radiology, X-ray: Production of X-ray, X-ray Machine, application X-ray, CT: Basic Principle, CT Scan system components, Ultrasound: Principle of Ultrasound, Application of ultrasound in biomedical. MRI: Basic Principle, MRI Scan system components.

Targeted Application & Tools that can be used:

Multisim for simulating the signal conditioners used in BMI. MATLAB, LabVIEW for preprocessing the raw data and extraction of features using signal and image processing. Any microcontrollers and FPGA for developing embedded systems for Biomedical Field for processing, displaying recording and transmitting the real time data.

Textbook(s):

1. **R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill Education, 3rd edition, 2014.**
2. **J. Webster, "Medical Instrumentation: Applications and Design", John Wiley and Sons, 4th edition, 2009.**

References

1. **Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice Hall India Learning Private Limited, 1st edition, 1990.**
2. **Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation", Prentice Hall India Learning Private Limited, 1st edition, 2013.**

Digital References

NPTEL - https://nptel.ac.in/courses/108/105/108105101/
Coursera - https://www.coursera.org/learn/bioengineering
Udemy - https://www.udemy.com/course/biomedical-engineering-instrumentation-course-rahbme216-rahsoft/

E-Contents

1. Karthick, R., R. Ramkumar, Muhammad Akram, and M. Vinoth Kumar. "Overcome the challenges in bio-medical instruments using IOT–A review." *Materials Today: Proceedings* 45 (2021): 1614-1619.
2. Fedtschenko, Tatjana, Alexander Utz, Alexander Stanitzki, Andreas Hennig, Andre Lüdecke, Norbert Haas, and Rainer Kokozinski. "A new configurable wireless sensor system for biomedical applications with ISO 18000-3 interface in 0.35 µm CMOS." *Sensors* 19, no. 19 (2019): 4110.
3. Vavrinský, Erik, Martin Daříček, Martin Donoval, Karol Rendek, František Horínek, Martin Horniak, and Daniel Donoval. "Design of EMG wireless sensor system." In *2011 International Conference on Applied Electronics*, pp. 1-4. IEEE, 2011.
4. Rendek, K., M. Daříček, E. Vavrinský, M. Donoval, and D. Donoval. "Biomedical signal

amplifier for EMG wireless sensor system." In *The Eighth International Conference on Advanced Semiconductor Devices and Microsystems*, pp. 251-254. IEEE, 2010.	
Topics relevant to "EMPLOYABILITY SKILLS": Wireless Connectivity in Medical Instruments, Phonocardiograph (PCG) for heart sound measurement, Basics of diagnostics radiology, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Ajit Kumar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3035**	**Course Title: Biomedical Signal Processing** **Type of Course: Discipline Elective- Signal Processing Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts and techniques for processing of discrete-time signals, systems and transforms. Understanding of FIR and IIR Filters; Discrete Fourier Transform (DFT) and Fast Fourier transform (FFT) techniques and their applications; Implementation of DSP algorithms on DSP processors.					
Anti-requisites	NIL					
Course Description	The course describes the origin and characteristics of biomedical signals collected from humans. This course imparts knowledge of signal processing methods to analyze the health status of individuals in order to differentiate between a healthy and an unhealthy person. The course also develops critical thinking to choose and apply a signal model for a specific set of physiological disorders. The comprehensive nature of the course covers a number of quizzes and signal processing assignments using various tools to enhance students' abilities to become an independent biomedical engineer.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Biomedical Signal Processing and to improve the Employability Skills of student by using Participative Learning techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: (i) Discuss the origin and characteristics of various biosignals. (ii) Apply various analog and digital filtering techniques for removal of noise and artifacts. (iii) Demonstrate various feature extraction and event detection techniques using time-domain as well as frequency-domain analysis methods. (iv) Employ various parametric and non-parametric models of certain physiological systems.					
Course Content:						
Module 1	**Biosignals and its Origin**	Quiz	Memory Recall based Quizzes			**12 Classes**
Introduction to biosignals: Human anatomy and physiology, Electrical activities of a Cell, Origin and dynamics of Biomedical signals, Electrocardiography (ECG) signal origin and characteristics. Electroencephalography (EEG) signal and its characteristic. Electromyography (EMG) signal and its characteristic. Other Biomedical signals – Blood Pressure, Respiration, Electrooculogram (EOG) etc.						
Module 2	**Noise Removal and Processing of Biosignals**	Assignment / Quiz	Programming and Simulation task			**12 Classes**
Review of Discrete time signals and systems, Analog filters, Digital filters. Time domain filtering - Synchronized Averaging, Moving Average etc., Frequency Domain Filtering, The Weiner Filter, Adaptive Filtering, Adaptive interference cancellation. Filtering of physiological signals.						

Module 3	**Analysis of Biosignals**	Assignment	Memory Interfacing Task and Analysis	**15 Classes**
Practices followed for data collection from opposite gender patients. Feature Extraction and Event Detection from ECG (P, QRS and T Waves detection, Pan Tompkins Algorithm for QRS Detection), EEG and EMG signals.Time-domain Analysis – Biosignal Morphologies, Signal length, Envelop Extraction, Amplitude demodulation, The Envelogram, Activity Analysis etc.Frequency-domain Analysis – Periodogram, Averaged Periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, and Measures derived from Power Spectra Density.				
Module 4	**Modelling of Biomedical Signals and Systems**	Assignment	System Design Task and Analysis	**06 Classes**
Parametric Modelling of Biomedical Systems, Various Signal models like Autoregressive, Autocorrelation method, ARMA model etc., Random signals and their processing, Overview of Advanced Topics.				

Targeted Application & Tools that can be used:

Application Area is Biomedical Signal Processing applications leading to design of medical devices and systems.

Professionally Used Software: Matlab / Python / LabVIEW.

Textbook(s):

1. Sörnmo L. and Laguna P, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", Academic Press, 1st edition, Elsevier, 2005.
2. Willis J. Tompkins " Biomedical Digital Signal Processing", 2nd edition, EEE, PHI, 2004.

Reference(s):

1. Devasahayam S. R., "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling", Kluwer Academic/Plenum Publishers, 5th edition, New York, 2000.
2. Reddy D. C., "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005.
3. Rangayyan R. M. "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. MIT Open Course Ware Lecture Notes on "Biomedical Signal and Image Processing". https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/pages/lecture-notes/
2. Prof. Sudipta Mukhopadhyay NPTEL Lecture Notes and Videos: https://nptel.ac.in/courses/108105101
3. Fatemeh Hadaeghi Lecture Notes (from Jacobs University Bremen): https://www.ai.rug.nl/minds/teaching/courses/t2018biomed/
4. Dr. Kunal Pal's Video lectures on "Biomedical Signal Processing" from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8
5. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. M. L. Ahlstrom and W. J. Tompkins, "Digital Filters for Real-Time ECG Signal Processing Using Microprocessors," in *IEEE Transactions on Biomedical Engineering*, vol. BME-32, no. 9, pp. 708-713, Sept. 1985, doi: 10.1109/TBME.1985.325589. https://ieeexplore.ieee.org/abstract/document/4122146
2. Coté, Gerard L., Ryszard M. Lec, and Michael V. Pishko. "Emerging biomedical sensing technologies and their applications." *IEEE Sensors Journal* 3, no. 3 (2003): 251-266. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.415.7820&rep=rep1&type=pdf

3. James, Christopher J., and Christian W. Hesse. "Independent component analysis for biomedical signals." *Physiological measurement* 26, no. 1 (2004): R15. <https://iopscience.iop.org/article/10.1088/0967-3334/26/1/R02/meta> Available at Link: https://www.academia.edu/download/49895521/0967-3334_2F26_2F1_2Fr0220161026-21959-1bfp9y3.pdf
4. Addison, Paul S. "Wavelet transforms and the ECG: a review." *Physiological measurement* 26, no. 5 (2005): R155. https://people.uwec.edu/walkerjs/primer/Papers/Addison_EEG_Review.pdf
5. Moraes, Jermana L., Matheus X. Rocha, Glauber G. Vasconcelos, José E. Vasconcelos Filho, Victor Hugo C. De Albuquerque, and Auzuir R. Alexandria. "Advances in photopletysmography signal analysis for biomedical applications." *Sensors* 18, no. 6 (2018): 1894.https://www.mdpi.com/1424-8220/18/6/1894/pdf

Topics relevant to "EMPLOYABILITY SKILLS": Analysis of ECG / EMG / EEG signals, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms. Natya. S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3036**	**Course Title:** **Probabilistic Systems analysis** **Type of Course:** **Discipline Elective- Signal Processing Basket**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	A college-level course in calculus and statistics is desirable. The students should be aware of double integrations and methods for solving partial differential equations.					
Anti-requisites	**NIL**					
Course Description	This course provides insights into the modeling and analysis of real-world random phenomena and processes, including the basics of statistical inference. The course introduces the relevant models, skills and tools, by combining mathematics with conceptual understanding and intuition. The assignment-based practices in this course lay a firm foundation for building probabilistic models in various application domains.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using open source Design Tools.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) **Discuss** the basics of probability, sample space, events, statistics and apply them to real life problems 2) **Distinguish** probability density and distribution functions for single and multiple random variables and calculate the statistical parameters for random variables 3) **Apply** the concept of random processes along with its parameters in estimating the correlation, covariance and PSD.					
Course Content:						
Module 1	Probability Theory and Probability Statistics	Assignment	Problem Solving Task	**7 Sessions**		
Topics: Probability models and axioms, Conditioning and Bayes' rule, Independence, Counting						
Module 2	Random Variables	Assignment	Problem Solving Task	**10 Sessions**		
Topics: Discrete random variables; probability mass functions; expectations, Discrete random variable examples; joint PMFs, Multiple discrete random variables: expectations, conditioning, independence, Continuous random variables, Multiple continuous random variables						
Module 3	Distribution Functions and Random Processes	Assignment	Problem Solving Task	**11 Sessions**		
Topics: Continuous Bayes rule; derived distributions, Derived distributions; convolution; covariance and correlation, Iterated expectations; sum of a random number of random variables, Bernoulli process, Poisson process, Markov chains, Weak law of large numbers, Central limit theorem, Bayesian statistical inference, Classical statistical inference						

Module 4	Detection, estimation and filtering	Assignment	Problem solving task	**17** sessions

Statistical decision theory - Bayes' criterion (Binary hypothesis, M-ary hypothesis), minimax criterion, Neyman-Pearson criterion, sequential detection, Estimation-maximum likelihood estimation, generalized likelihood ratio test, Bayes' estimation (minimum mean-square error estimate, minimum mean absolute value of error estimate, maximum a posteriori estimate), Cramer-Rao Inequality, Multiple Parameter Estimation, least-square estimation, Filtering-Wiener filter, Kalman filter

Targeted Application & Tools that can be used:

Application Areas: Exploratory decision making, Machine Learning, Artificial Intelligence and Data analysis, computer vision, natural language processing, computational biology, Statistics and Statistical Signal Processing Domain.

TOOLS: Python and R programming.

Project work/Assignment:

Assignment 1: Problem solving assignment on probability theory
Assignment 2: Problem solving assignment on random variables
Assignment 3: Problem solving assignment on random processes
Assignment 4: Problem solving assignment on queuing theory

Textbook(s):

1. Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2nd Edition, Wiley, 2016
2. Mourad Barkat, "Signal detection and estimation", 2e, Artech House, 2005

References:

1. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability. 2nd ed. Athena Scientific, 2008. ISBN: 9781886529236.

2. Athanasios Papoulis and S. Unnikrishnan Pillai, "Probability, Random Variables and Stochastic Processes", 4th edition, PHI, 2002.

3. Henry Stark and John W. Woods, "Probability and Random Processes with Application to Signal Processing", 3rd edition, Pearson Education, 2009

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Probabilistic Systems Analysis and Applied Probability (amser.org)
2. Introduction To Applied Probability | Udemy
3. Probability Theory and Stochastic Processes with Applications
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content

1. https://www.researchgate.net/publication/309793344_Reliability_sensitivities_with_fuzzy_random_uncertainties_using_genetic_algorithm
2. https://www.researchgate.net/publication/333449747_Methodologies_for_Assessing_Risks_of_Accidents_in_Chemical_Process_Industries
3. https://www.researchgate.net/publication/226742073_Modelling_Technologies_and_Applications
4. https://www.researchgate.net/publication/327826061_Modelling_Technologies_and_Applications_Nanotechnologies_and_Electronics_Packaging

Topics relevant to development of "Foundation Skills": Probability models and axioms; probability mass functions; expectations.

Catalogue prepared by	Dr. Sumantra Chaudhuri
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE3037</td><td colspan="4">Course Title: Audio Signal Processing for Music Applications

Type of Course: Discipline Elective- Signal Processing Basket</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">Basic signal processing operations, analysis and representation of signals</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">The course is designed for undergraduate level engineering students. The aim of this course is to introduce the students to the areas of Audio signal processing for musical applications. Audio signal Processing coders, music synthesis and retrieval are discussed in the course. This course develops a basic understanding of the analysis of music signals with the help of various signal processing techniques. These topics will enable the students to select employment opportunities and research and development activities.</td></tr>
<tr><td>Course Objective</td><td colspan="9">The objective of the course is to familiarize the learners with the concepts of Audio Signal Processing for Music Applications to improve the learners' Employability Skills by Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
1) Recall the various signal processing techniques.
2) Describe the sinusoidal model coders, FM synthesis and music synthesis
3) Explain the music signal analysis and music retrieval.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td>Introduction to discrete signal processing</td><td>Assignment</td><td>Programming Task</td><td>10 Classes</td></tr>
<tr><td colspan="5">Topics:
Introduction: Spectra of analog signals, Discrete Fourier transform, Fourier theorems, Fast Fourier transforms, Short Time Fourier transforms, Digital Filters, Examples of digital filters for audio applications, review of multirate signal processing, discrete time random signals.</td></tr>
<tr><td>Module 2</td><td>Sinusoidal coders</td><td>Assignment</td><td>Programming Task</td><td>10 Classes</td></tr>
<tr><td colspan="5">Topics:
Sinusoidal model: Sinusoidal analysis and parameter tracking, sinusoidal synthesis and parameter interpolation. FM synthesis, Hybrid sinusoidal coders. Music synthesis concepts, analysis based synthesis. Reverberation and other techniques of Music synthesis, Examples of music synthesis.</td></tr>
<tr><td>Module 3</td><td>Musical signal analysis</td><td>Project Assignment</td><td>Programming Task</td><td>10 Classes</td></tr>
<tr><td colspan="5">Topics:
Musical signal analysis: Information in music audio, Music analysis and synthesis, Innovations in musical signal processing: Wavelet representation, Granular synthesis, Analysis with chaos, Acoustic modelling using digital waveguide.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Targeted Applications: Music industry, Design and development of musical instruments, Audio signal processing research areas</td></tr>
</table>

Professionally Used Software: Python open software, matlab /simulink

Textbook

1 Andreas Spanias, Ted Painter, Venkatraman Atti, "Audio Signal Processing and Coding", A John Wiley & Sons, Inc , 11-Sep-2006.

2 Curtis Roads, Stephen Travis Pope, Aldo ,"Musical Signal Processing, Swets and Zeitlinger Publishers, second edition

Reference(s)

1 Oppenheim, Schafer, Buck, "Discrete Time Signal Processing", 2nd edition, Prentice hall .

2 Ben Gold, Nelson Morgan, Dan Ellis, "Speech and audio signal Processing- Processing and perception of speech and music", A John Wiley & Sons, Inc., Publication, second edition

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL video lecture on "Digital Signal Processing" by IIT Delhi, Prof. S C Dutta Roy https://nptel.ac.in/courses/117102060
2. NPTEL video lecture on "Digital Speech Processing" by IIT Kharagpur, Prof. Shyamal Kumar das Mandal https://nptel.ac.in/courses/117105145
3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. George Tzanetakis, Perry Cook ,"Musical genre classification of audio signals", Published in: IEEE Transactions on Speech and Audio Processing (Volume: 10, Issue: 5, July 2002 10.1109/TSA.2002.800560
2. Tsuhan Chen, " Recent development in multimedia signal processing: a review on audio-visual interaction", Published in: Proceedings of 13th International Conference on Digital Signal Processing 10.1109/ICDSP.1997.628007
3. Meinard Muller, Max-Planck Institut für Informatik, Saarbrücken, Germany, Daniel P. W. Ellis; Anssi Klapuri; Gaël Richard, "Signal Processing for Music analysis" Published in: IEEE Journal of Selected Topics in Signal Processing (Volume: 5, Issue: 6, October 2011)

Topics relevant to "EMPLOYABILITY SKILLS": Music analysis and synthesis, cover song matching, music classification and auto tagging, music similarity checking, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Amrutha V Nair
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3038**	**Course Title: Electronic Music Production** **Type of Course: Discipline Elective- Signal Processing Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	[1] Digital Signal Processing, Basic high school math, Probability and Statistics, Linear Algebra, Computer programming, Basic Music Theory						
Anti-requisites	NIL						
Course Description	The course is specially designed for candidates dealing with electrical, electronics, and communications engineering. In the Electronic Music Production specialization, students will learn the tricks of the trade to create high-quality, professional sounding music. They will begin by learning about the nature of sound and how a signal flows through a home studio setup. Additionally, they will learn how to create their own custom musical sounds through music synthesis.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Electronic Music Production to improve the learners' Employability Skills by Participative Learning.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Explain the concept of signal processing and music theory. 2. Discuss and design different algorithms of music production. 3. Understand various issues in music production. 4. Illustrate the application of electronic music production through compositions.						
Course Content:							
Module 1	**Basics of Music Technology.**	Quiz	Memory Recall based Quizzes	**9 Sessions**			
Topics: Introduction, Music Production Process, Basics of Recording, Editing, and Mixing, Different tools available to create contemporary music on computer.Recording theory contemporary acoustic and digital recording practice, physics of sound and sound propagation. synthesis and sampling.							
Module 2	**Introduction to software (Ableton Live)**	Assignment	Assignment based on real time applications using Ableton	**10 Sessions**			
Topics: Introduction to different existing software, MIDI programming, audio recording, warping and processing, looping editing, mixing, performing, file management, and troubleshooting.							
Module 3	**Creating Sounds for Electronic Music**	Assignment	Comprehension based Quizzes and assignments; simulation with Ableton	**10 Sessions**			
Topics: Introduction to synthesizers, Database creation of designed sounds, or patches, to use in compositions, Introduction to FXpansion Strobe 2**.**							
Module 4	**Electronic Music Performance Techniques** Emerging Technologies	Assignment	Assignment on building music using software	**10 Sessions**			
Topics: Introduction to Electronic Digital Instruments (EDI), Building an arrangement on EDI, Building drum beats and reading drum notation, Programmatic advertising, virtual reality, 3D printing, and Internet of Things							

Targeted Application & Tools that can be used:

Composition of new music, Similarity retrieval, playlists, recommendation, Classification and clustering, Tag annotation, Rhythm, melody, chords, Music transcription and source separation
Professionally Used Software: Ableton, FXpansion Strobe 2

Text Book(s):

2. Music Production, 2020 Edition: The Advanced Guide On How to Produce for Music Producers by Tommy Swindali

Reference Book(s)

3. Music Production For Beginners 2020 Edition: How to Produce Music, The Easy to Read Guide for Music Producers by Tommy Swindali
4. Music Theory for Electronic Music Producers 2018 Edition - The Producer's Guide to Harmony, Chord Progressions, and Song Structure in the MIDI Grid by J. Anthony Allen

Online Resources (e-books, notes, ppts, video lectures etc.):

9. Appreciating Carnatic Music by Prof. Lakshmi Sreeram - IIT Madras(NPTEL) https://onlinecourses.nptel.ac.in/noc20_hs90/preview
10. Music Production, 2020 Edition: The Advanced Guide On How to Produce for Music Producers by Tommy Swindali https://www.google.co.in/books/edition/Music_Production_2020_Edition_The_Advanc/zGf5DwAAQBAJ?hl=en&gbpv=1
11. Electronic Music Production Specialization https://www.coursera.org/specializations/electronic-music-production
12. Learn How to Make Electronic Music with Cubase https://www.udemy.com/course/jumpstart-your-music-production-career-with-cubase/

E-content:

1. L. Liang and J. Liu, "An exploration of the application of computer music production software in music composition," *2021 IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC)*, 2021, pp. 794-796, doi: 10.1109/IPEC51340.2021.9421093. https://ieeexplore.ieee.org/document/9421093
2. Y. Wang, "The Application of Computer Music Production Software in Music Creation," *2021 International Conference on Computer Technology and Media Convergence Design (CTMCD)*, 2021, pp. 107-110, doi: 10.1109/CTMCD53128.2021.00031. https://ieeexplore.ieee.org/document/9463370
3. V. Bauer and T. Bouchara, "First Steps Towards Augmented Reality Interactive Electronic Music Production," *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, 2021, pp. 90-93, doi: 10.1109/VRW52623.2021.00024. https://ieeexplore.ieee.org/document/9419126
4. P. Saari, G. Fazekas, T. Eerola, M. Barthet, O. Lartillot and M. Sandler, "Genre-Adaptive Semantic Computing and Audio-Based Modelling for Music Mood Annotation," in *IEEE Transactions on Affective Computing*, vol. 7, no. 2, pp. 122-135, 1 April-June 2016, doi: 10.1109/TAFFC.2015.2462841 https://ieeexplore.ieee.org/document/7173419

Topics relevant to "EMPLOYABILITY SKILLS": Music synthesis, creating sounds, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Azra Jeelani
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3039	**Course Title: DSP Processors Type of Course: Discipline Elective- Signal Processing Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of simple high school math on trigonometry, complex numbers, signals and systems, Digital signal Processing algorithm computations, and a little familiarity with programming especially numerical computation.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of DSP processors. The course imparts the knowledge of basic DSP concepts and number systems to be used, different types of conversion errors. The course emphasizes the architectural differences between DSP and General purpose processor.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of DSP Processors to improve the learners' Employability Skills by Participative Learning.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the basics of Digital Signal Processing and transforms. 2. Able to distinguish between the architectural features of General purpose processors and DSP processors. 3. Understand the architectures of TMS320C54xx devices and Acquire knowledge about various addressing modes 4. Discuss about various memory and parallel I/O interfaces					
Course Content:						
Module 1	**Introduction To Digital Signal Processing**	Quiz	Memory Recall based Quizzes		**12 session**	
Introduction to Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. Review of Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), linear time-invariant systems, Digital filters, Decimation and interpolation. **Computational Accuracy in DSP Implementations:** Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors						
Module 2	**Architectures for Programmable DSP Devices and Pipelining**	Assignment / Quiz	Programming and Simulation task		**12 session**	
Topics: **Commercial Digital signal-processing Devices**, Data Addressing modes of TMS320C54XX DSPs, Memory space, Program Control, instructions and Programming, On-Chip Peripherals, Interrupts, Pipeline Operation.						
Module 3	**Implementations of Basic DSP Algorithms**	Assignment	Analysis and Verification		**10 session**	
The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing, An FFT Algorithm for DFT Computation, A						

Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX				
Module 4	**Interfacing Memory And I/O Peripherals**	Assignment	Analysis and Verification	**10 session**
Topics: Memory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct memory access (DMA).				
Targeted Application & Tools that can be used: Code Composer studio with C / C++ compiler for TI C6xxx DSPs, can be used for implement DSP algorithms.				
Text Book(s): **14.** Avtar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004 15. .B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications‖, Tata				
Reference(s): **Reference Book(s):** 13. Jonatham Stein, Digital Signal Processing‖, John Wiley, 1st Edition, 2000. 2. Sen M. Kuo & WoonSergGan, 14. Digital Signal Processors Architectures, Implementation and Application‖, Pearson Practice Hall, 1st Edition, 2013 15. Digital Signal Processing –Principles, Algorithms Applications by J.G. Proakis & D.G. Manolokis, PHI, 2005 **Online Resources (e-books, notes, ppts, video lectures etc.):** 6. Lecture series on Embedded Systems by Dr.Santanu Chaudhury, Dept. of Electrical Engineering, IIT Delhi http://nptel.iitm.ac.in 2. TMS320C54XX data sheet, product information and support https://www.ti.com/ 3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home **E-content:** 18. Gustavo Ruiz, Juan A. Michell, Design and Architectures for Digital Signal Processing. 2013, https://www.intechopen.com/books/3158 19. "Quad DSP board gives processor-hungry applications a performance boost", Aircraft Engineering and Aerospace Technology, Vol. 71 No. 5. https://doi.org/10.1108/aeat.1999.12771ead.002 https://www.emerald.com/insight/content/doi/10.1108/aeat.1999.12771ead.002/full/html				
Topics relevant to "EMPLOYABILITY SKILLS": Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.				
Catalogue prepared by	Mrs. KEHKESHAN JALALL S			

Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3093	**Course Title: Machine learning for Music Information Retrieval** **Type of Course Discipline Elective- Signal Processing Basket**	**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Signal Processing, Basic high school math, Probability and Statistics, Linear Algebra, Computer programming, Basic Music Theory					
Anti-requisites	NIL					
Course Description	This course offers a comprehensive introduction to the emerging research area of Music Information Retrieval (MIR). Topics include techniques from signal processing, machine learning, information retrieval, human-computer interaction, and software engineering. These are applied in the design and development of MIR algorithms and systems.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: 5) Explain the concept of signal processing and music theory. 6) Discuss and design different algorithms of MIR. 7) Understand various issues in music information retrieval. 8) Illustrate the application of MIR in real time applications.					
Course Content:						
Module 1	**Basic Signal processing techniques**	Quiz	Memory Recall based Quizzes		**9 Sessions**	
Topics: Fundamentals of signal processing, Sampling Theorem, Introduction to Music signals, Basic of Music Theory						
Module 2	**Extracting Information From Music Signals**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB		**10 Sessions**	
Topics: Time, Frequency, and Sinusoids, DFT and Time-Frequency Representations, Monophonic Pitch Detection, Audio Feature Extraction, Rhythm Analysis						
Module 3	**Machine Learning for Music Information**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB		**10 Sessions**	
Topics: Supervised Learning and Naive Bayes Classification, Discriminative Classifiers Genre Classification, Emotion Recognition and Regression, Tags, Music Visualization						
Module 4	**Music Retrieval**	Assignment	System Design Task		**10**	

	Systems Toolbox for Music Information Retrieval		and Analysis	**Sessions**

Topics:
Query Retrieval, Polyphonic Alignment and Structure Segmentation, Chord Detection and Cover Song Identification, Transcription and Sound Source Separation, Audio Fingerprinting and Watermarking

Toolbox for Music Information Retrieval:Motivation and approach, Feature extraction, pitch xtraction , Recent developments and Applications.

Targeted Application & Tools that can be used:
Similarity retrieval, playlists, recommendation, Classification and clustering, Tag annotation, Rhythm, melody, chords, Music transcription and source separation, Query by humming, Symbolic MIR, Segmentation, structure, alignment, Watermarking, fingerprinting and cover song detection

Professionally Used Software: MATLAB, Audacity, Sonic Visualizer

Project work/Assignment/Quiz:

1. Case Study: At the end of the course students will be given a 'real-world' application based on MIR tools as a case study. Students will be submitting a report which will include Block diagrams, Design, Working Mechanism and Results etc. in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: Students will be given different tasks based on learning from each module.
Assignment 1: Implement various signal processing techniques on music signal to find the scale and pitch.
Assignment 2: Implement various signal processing techniques on music signal for singer identification/ genre identification

5. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

Text Book(s):

3. An Introduction to Music Information Retrieval and Signaling schemes by Akhilesh K Sharma

Reference Book(s)

5. Music Information Retrieval Recent Developments and Applications by Markus Schedl, Emilia Gomez, Julian Urbano
6. Information Retrieval Architecture And Algorithms 1st Edition by Kowalski Gerald

Online Resources (e-books, notes, ppts, video lectures etc.):

13. Machine Learning for Music Information Retrieval by Dr. George Tzanetakis https://www.kadenze.com/courses/machine-learning-for-music-information-retrieval/info
14. Audio Signal Processing for Music Applications (Coursera)

https://www.coursera.org/learn/audio-signal-processing

15. A Matlab Toolbox for Music Information Retrieval, https://link.springer.com/chapter/10.1007/978-3-540-78246-9_31
16. Fundamentals of Music Processing Using Python and Jupyter Notebooks By Meinard Müller https://www.google.co.in/books/edition/Fundamentals_of_Music_Processing/fYsoEAAAQBAJ?hl=en&gbpv=1

E-content:

5. Tao Li and M. Ogihara, "Toward intelligent music information retrieval," in *IEEE Transactions on Multimedia*, vol. 8, no. 3, pp. 564-574, June 2006, doi: 10.1109/TMM.2006.870730. https://ieeexplore.ieee.org/abstract/document/1632041
6. Casey, M. A., Veltkamp, R., Goto, M., Leman, M., Rhodes, C., & Slaney, M. (2008). Content-based music information retrieval: Current directions and future challenges. *Proceedings of the IEEE*, *96*(4), 668-696. https://www.sciencedirect.com/science/article/abs/pii/S0306457301000334
7. Byrd, D., & Crawford, T. (2002). Problems of music information retrieval in the real world. *Information processing & management*, *38*(2), 249-272. https://www.sciencedirect.com/science/article/abs/pii/S0306457301000334
8. Jiayin Sun, Haifeng Li and Li Lei, "Key detection through pitch class distribution model and ANN," *2009 16th International Conference on Digital Signal Processing*, 2009, pp. 1-6, doi: 10.1109/ICDSP.2009.5201119. https://ieeexplore.ieee.org/document/5201119

Topics relevant to development of "SKILL": Music signal processing.
Topics relevant to development of "EMPLOYABILITY": Chord detection, Music Retrieval Systems
Topics relevant to development of "ENVIRONMENT AND SUSTAINABILITY SKILLS": Extracting Information From Music Signals

Catalogue prepared by	Dr.Azra Jeelani
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3094	**Course Title: Video Processing and Computer Vision** **Type of Course: Discipline Elective- Signal Processing Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Digital Image Processing, Signals and Systems, Transforms and Techniques					
Anti-requisites	NIL					
Course Description	This course aims to introduce students to a wide range of video processing and computer vision techniques. The purpose of this course is to familiarize the students with the fundamental ideas and problems in computer vision and video processing as well as the main solutions. An introduction to computer vision is provided in this course, along with advanced ideas like motion estimation and tracking, image classification, scene understanding, object categorization and tracking, image fusion, image registration, etc.					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Know the fundamental techniques for video processing, and computer vision 2) Understand the basics of analog and digital video: video representation and transmission 3) Understand the basics of computer vision 4) Familiarize himself/herself with computer vision algorithms and applications					
Course Content:						
Module 1	Introduction to Video Processing	Quiz	Memory Recall based Quizzes	**09 session**		
Topics: Video data, video acquisition, video representation, Video data representation, sensors for video acquisition, working of digital camera (block diagram), camera resolution and color conversion, types of video cameras general mathematical operations for video processing, Color perception and specifications, color representation, video formats (NTSC, SECAM, PAL, VGA, HD), video storage requirements, video indexing						
Module 2	Video Processing	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**12 session**		
Topics: Sampling in spatial and temporal domains, sampling conversion, video to frames and frames to video Pre-filter in video cameras, interpolation filter in video displays, Fourier analysis of video sequence, spatial frequency, temporal frequency, temporal frequency caused by motion.						
Module 3	Introduction to Computer	Assignment	Programming Assignment	**12 sessi**		

	Vision and Algorithms			**on**
Topics: Introduction to Computer Vision, Image Processing VS Computer Vision, Color Vision, Camera and Epipolar Geometry, Auto-calibration Motion estimation: - Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.				
Module 4	Applications of Computer Vision	Assignment	Programming Assignment	**12 session on**
Topics: Object detection and tracking various scenarios, Pattern Analysis, Face recognition and Tracking, Applications of computer vision in robotics and Autonomous Vehicles (ADAS)				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: **Targeted Applications:** Security and Surveillance, ADAS, Industry 4.0 Professionally Used Software: Python/ MATLAB/ SCILAB				
Project Work/Assignment:				
1. Case Study: At the end of the course students will be given a 'real-world' application-based on Computer Vision and Video Processing as a case study. Students will be submitting a brief report in appropriate format **2 Article review:** At the end of the course a literature review of any 01 recent articles from the reputed national and international journal/ conferences will be given by students. They need to refer to tools like Scopus/ Google-Scholar and submit a report on their understanding of the assigned article in appropriate format. **3. Presentation:** There will be a group presentation, where the students will be given a topic. They will have to present their review work.				
Text Book(s): 2. AL BOVIK, "Handbook of Image and Video Processing," Elsevier Science, 2nd Edition. **3.** Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011, 1st Edition.				
Topics relevant to the: "FOUNDATION SKILLS", Introduction to Computer Vision, , Image Processing VS Computer ision Topics related to development of "EMPLOYABILITY": Object detection and tracking various scenarios, Pattern Analysis, Face recognition and Tracking, Applications of computer vision in robotics and Autonomous Vehicles (ADAS)				
Catalogue prepared by	Mr. Kiran Dhanaji Kale			
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024			
Date of Approval by	Academic Council Meeting No. 24th , Dated 03/08/2024			

the Academic Council	

Course Code: ECE3096	**Course Title: Natural Language Processing** **Type of Course: Discipline Elective- Signal Processing Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Prior exposure to discrete math, probability, linear algebra, optimization, linguistics, artificial intelligence, machine learning and familiarity with python will be useful but not required					
Anti-requisites	**NIL**					
Course Description	This course is intended as a theoretical and methodological introduction to the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language through programming and simulation.					
Course Objective	This course is designed to develop Entrepreneurial skills by using Experiential Learning Techniques					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Understand basics in natural language processing methods and strategies. (2) Evaluate the strengths and weaknesses of various NLP technologies and frameworks (3) Employ literary-historical NLP-based analytic techniques like stylometry, topic modeling, synsets and named entity recognition.					
Course Content:						
Module 1	Syntactic Processing	Assignment	Programming and Simulation task	**09 Sessions**		
Topics: Introduction, Linguistic Background, Grammars and Parsing, Features and Augmented Grammars, Grammars for Natural Language, Toward Efficient Parsing, Ambiguity Resolution: Statistical Methods						
Module 2	Semantic Interpretation	Assignment	Programming and Simulation task	**11 Sessions**		
Topics: Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity Resolution, Other Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases.						
Module 3	Context and World Knowledge	Assignment	Programming and Simulation task	**10 Sessions**		
Topics: Knowledge Representation and Reasoning, Local Discourse Context and Reference, Using World Knowledge, Discourse Structure, Defining a Conversational Agent						
Module 4	INFORMATION RETRIEVAL AND LEXICAL RESOURCES:	Assignment	Programming	**12 Sessions**		

Topics:
Information Retrieval: Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame NetStemmers-POS Tagger- Research Corpora.

Targeted Application & Tools that can be used:
Application Area: Information Extraction, Machine Translation
Professionally Used Software/Platforms/APIs/Library:

1. MonkeyLearn
2. AYLIEN

Project work/Assignment:

Assignment 1: Classification for Person Name Detection.
Assignment 2: CRF tagging for NER
Assignment 3: Neural Networks for Sentiment Analysis
Assignment 4: Encoder-Decoder Models for Question Answering

Text Book

1. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming.

References

1. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
3. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python–Analyzing Text with the Natural Language Toolkit (O'Reilly 2009, website 2018)
4. Dipanjan Sarkar, Text Analytics with Python (Apress/Springer, 2016)

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Natural Language Tool Kit
2. Stanford University CS224n: Natural Language Processing with Deep Learning
3. Paul Vierthaler's Stylometric PCA and Network Data Explorer
4. NLP 100 Exercise 2020 (Rev 2) - NLP100 2020
5. Natural Language Processing and Machine Learning (princeton.edu)

E-content:

1. M. Chandhana Surabhi Velalar College of Engineering and Technology (July 2013) , "Natural language processing future", International Conference on Optical Imaging Sensor and Security (ICOSS),2013 Coimbatore, India https://ieeexplore.ieee.org/document/66784072.
2. Cher Don Liew, Murdoch University, "Survey of Machine Learning Algorithms Used in Natural Language Processing and Understanding Task", October 2021 https://www.researchgate.net/publication/358696237
3. Yulia Yu. Dyulicheva1, Elizaveta A. Bilashova Vernadsky Crimean Federal University, Vernadsky Ave., Simferopol, 295007, Crimea,"Learning analytics of MOOCs based on natural language processing", Conference: 4th Workshop for Young Scientists in Computer Science & Software EngineeringAt: Kryvyi Rih, Ukraine, December 18, 2021. https://www.researchgate.net/publication/357173866
4. Kai Jiang, College of Foreign Languages, Huazhong Agricultural University, Wuhan, China Natural "Language Processing and Its Applications in Machine Translation: A Diachronic Review" 2020 IEEE 3rd International Conference of Safe Production and Informatization (IICSIP), November 2020,

https://ieeexplore.ieee.org/document/9332458**Other Resources:**	
Topics relevant to development of "FOUNDATION SKILLS":	
Catalogue prepared by	Dr. Rajiv Ranjan Singh
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: **ECE3105**	**Course Title: Wavelets and Filter Banks (Open Elective)** **Type of Course: Discipline Elective- Signal Processing Basket**	**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Signal Processing; Matlab; Linear Algebra.					
Anti-requisites	NIL					
Course Description	The course mainly involves the theories of multirate filter banks (FBs) and wavelet, in addition, and their applications. It falls into two sections: FBs and wavelet. The first section begins with the design of filter, and then introduces the fundamental concepts, properties and theory of multirate FBs. Furthermore, several types of FBs, such as cosine-modulated FBs, linear phase FBs, time varying FBs, 2-dimmensional FBs, directional FBs, are analyzed. In the end of this section, the applications of FBs in communication are introduced.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using AI & IOT.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the terminologies that are used in the wavelets literature. 2. Understand the concepts and theory behind wavelets constructions from an Interdisciplinary apporoach 3. Be familiar with the modern signal processing using signal spaces, bases, operators and series expansions. 4. Apply wavelets and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool					
Course Content:						
Module 1	Introduction and filter design techniques	Quiz	Memory Recall based Quizzes	**12 Sessions**		
Topics: Multirate system fundamentals, Multirate filter design techniques: IFIR and FM approach, Design of two-channel linear-phase/low-delay filter banks, Two band filter banks with FIR and IIR filters, *M*-channel maximally decimated filter banks, *M*-channel near-perfect-reconstruction cosine-modulated filter banks, *M*-channel perfect reconstruction cosine modulated filter banks.						
Module 2	Non-uniform filter banks	Assignment/Quiz	Theoretical Understanding	**10 Sessions**		
Topics: *M*-channel linear phase filter banks, Multiresolution analysis and wavelet theory, Comparison of wavelet and Fourier transform,						
Module 3	Filter banks and discrete wavelet transform	Assignment/Quiz	Theoretical Understanding	**11 Sessions**		
Topics:						

Wavelet with FIR and IIR filters I, Wavelet with FIR and IIR filters II, *M*-band wavelet, Wavelet design based on cosine modulated filter banks, Wavelet transform application: de-noising and compression, Matching wavelet.

Targeted Application & Tools that can be used:

- Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans multiplexers, Text-Image Compression: Lossy and Lossless,
- Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis,
- Geometric Modelling, Matrix Preconditioning, Multiscale Methods for Partial Differential Equations and Integral Equations.

Professionally Used Software:

- MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs,
- Wavelet Transforms on Complex Geometrical Shapes.

Project work/Assignment:

1. **Case Studies:** At the conclusion of each module, we will have a 'case-based' discussion session for approximately half the class period. Cases will be from lecture / journal article content by considering a 'real-world' scenario where the course concepts can be applied. We will post the case one week in advance. For each case, each student from each group formed will write a 1-2-page executive summary outlining their understanding, including relevant analyses, schematics, and graphs. Guidelines on report format will be provided with the first case.

2. **Book/Article review:** At the end of each module, a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. **Presidency University Library Link.**

3. **Presentation:** There will a group presentation on latest trends and advancements in Wavelets & Filter banks.

Text Book(s):

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks. Prentice-Hall. Englewood Cliffs, NJ: 1993.
2. G. Strang and T. Q. Nguyen, Wavelets and Filter Banks. Wellesley-Cambridge Press, Wellesley, MA, Revised Edition, 1998.
3. Stephane Mallat, A Wavlet Tour of Signal Processing. San Diego: Academic Press, 1999.

Reference(s):

1. M. Vetterli and J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, Englewood Cliffs, NJ, 1995.
2. Fusheng Yang, Engineering Analysis and Applications of Wavelet Transform. Science Press, BJ:1999.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL :: Electrical Engineering - NOC:Fundamentals of Wavelets, Filter Banks and Time Frequency Analysis
2. Lecture Notes | Wavelets, Filter Banks and Applications | Mathematics | MIT OpenCourseWare
3. Introduction to Wavelet.ppt (live.com)

E-content:

1. P. P. Vaidyanathan, "Multirate digital filters, filter banks, polyphase networks, andapplications: a tutorial", *Proc. IEEE*, vol. 78, no. 1, pp. 56-93, January 1990.
2. P. P. Vaidyanathan, "Theory and design of *M*-channel maximally decimated quadrature mirror filters with arbitrary *M,* having the prefect reconstructions property," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. 35, no. 4, pp. 476-492, April 1987.
3. R. D. Koilpillai and P. P. Vaidyanathan, "Cosine-Modulated FIR Filter Banks Satisfying Perfect Reconstruction," *IEEE Trans. Signal Processing,* vol. 40, no. 4, April 1992.
4. T.Q.Nguyen, "Near Perfect Reconstruction *Pseudo*-QMF Banks," *IEEE Trans. Signal Processing,* vol. 42, no. 1, pp. 65-76, January 1994.
5. T. Q. Nguyen, "A tutorial on Filter Banks and Wavelets," I*n Proc. IEEE International Conference on Digital Signal Processing,* Cypress, June 1995.
6. Y. P. Lin and P. P. Vaidyanathan, "Linear Phase Cosine Modulated Maximally Decimated Filter Banks with Perfect Reconstruction," *IEEE Trans. Signal Processing*, vol. 42, no. 11, November 1995.

Catalogue prepared by	Ms. Swetha G
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

VLSI and Embedded Systems Basket

Course Code: ECE3127	**Course Title: Electronic Systems and PCB Design** **Type of Course: Discipline Elective- VLSI and Embedded systems Design Basket**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**Basic knowledge of electronic components and their interfaces, knowledge of debugging tools, microprocessors and programming languages**.					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to enable the students to understand basic analog and digital circuits as well as design printed circuit boards, assemble and get them running. The course also demonstrates the use of numerous CAD and design tools such as schematic entry, PCB layout and routing, circuit simulators, MATLAB, and more.**					
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Understand** basic analog and digital circuits 2) **Apply** advance techniques, skills and modern tools for designing and fabrication of PCBs. 3) **Understand** Schematic and layout design flow using Electronic Design Automation (EDA) Tools. 4) **Understand** basic concepts of transmission line, crosstalk and thermal issues					
Course Content:						
Module 1	**Introduction to Electronics**	Quiz	Memory Recall based Quizzes			**12 session**
Topics: Boolean Algebra, Number systems, Current and Voltage, ohms law, power, Series & Parallel network, Resistor color Coding, Inductor, Capacitor, Diode, Transformers, Switching states with transistors, Mosfets.						
Module 2	**Introduction to Printed circuit board**	Assignment / Quiz	Programming task			**12 session**
Topics: Fundamental of electronic components, basic electronic circuits, Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of artwork.						
Module 3	**Design rules for PCB & Introduction to Electronic design automation(EDA) tools for PCB designing**	Assignment	Memory Recall based Quizzes			**10 session**
Topics: Design rules for Digital circuit PCBs, Analog circuit PCBs. Brief Introduction of various simulators, SPICE and PSPICE Environment, Selecting the Components Footprints as per						

design				
Module 4	**Introduction printed circuit board production techniques**	Assignment	Programming task	**09 session**

Topics:
Photo printing, filmmaster production, reprographic camera, basic process for double sided PCBs photo resists, Screen printing process, plating, relative performance and quality control, Etching machines, Solders alloys, fluxes, soldering techniques, Mechanical operations, Transmission lines and crosstalk

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Data analytics, Audio Systems, Medical imaging systems, Monitors: Heart rate, blood pressure, blood glucose monitors, Smartphones, smart watches, tablets, and radios .
Professionally Used Software: EDA tools, SPICE, PSPICE, Altium, NI Multisim, SOLIDWORKS, CAD SOFTWARE, Gerber File.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.
2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment: - Implementation of various concepts in PCB using EDA tools

Text Book(s):

16. Printed circuit board design ,fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006

Reference(s):
Reference Book(s):

16. Printed circuit Board Design and technology, Walter C. Bosshart
17. E. Fitzgerald, Arvin Grabel, David E. Higginbotham, Textbook of Basic Electrical Engineering –TMH Publishing
18. Printed Circuits Handbook, Sixth Edition,by Clyde F. Coombs, Jr, Happy T. Holden,Publisher: McGraw-Hill Education Year: 2016
19. Complete PCB Design Using OrCAD Capture and PCB Editor,Kraig Mitzner Bob Doe Alexander Akulin Anton Suponin Dirk Müller, 2nd Edition 2009.
20. Introduction to System-on-Package, Rao R Tummala&MadhavanSwaminathan, McGraw Hill, 2008
21. EMC and Printed circuit board ,Design theory and layout, Mark I Montrose IEEE compatibility society
22. Flexible Printed circuit board Design and manufacturing ,By Robert torzwell

Online Resources (e-books, notes, ppts, video lectures etc.):

7. Free online self-paced course :- https://www.udemy.com/course/crash-course-electronics-and-pcb-design/
8. Online notes : https://nptel.ac.in/courses/108108031
9. NPTEL online video content:- https://www.digimat.in/nptel/courses/video/108108031/L01.html
10. Online ppts :- https://www.slideshare.net/BhanuSharma4/pcb-designing
11. https://presiuniv.knimbus.com/user#/home

E-content:

20. N. M. Sapiee et al., "Design and Development of Printed Circuit Board (PCB) for Smart Calorie Counter System," 2022 9th International Conference on Electrical and Electronics Engineering (ICEEE), Alanya, Turkey, 2022, pp. 90-94, doi: 10.1109/ICEEE55327.2022.9772591. https://ieeexplore.ieee.org/document/9772591/authors#authors
21. T. Yan and M. D. F. Wong, "Recent research development in PCB layout," 2010 IEEE/ACM International Conference on Computer-Aided Design (ICCAD), San Jose, CA, USA, 2010, pp. 398-403, doi: 10.1109/ICCAD.2010.5654190. https://ieeexplore.ieee.org/document/5654190
22. R. Caillaud et al., "Design, manufacturing and characterization of printed circuit board embedded inductors for power applications," 2018 IEEE International Conference on Industrial Technology (ICIT), Lyon, France, 2018, pp. 694-699, doi: 10.1109/ICIT.2018.8352262. https://ieeexplore.ieee.org/document/8352262

Topics related to development of "FOUNDATION": basic electronic circuits, Basics of printed circuit board designing.
Topics related to development of "EMPLOYABILITY": Design rules for Digital circuit PCBs, Analog circuit PCBs, Layout planning,
Topics related to development of "ENTREPRENEURSHIP": Etching machines, Solders alloys, fluxes, soldering techniques, Mechanical operations
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY":
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Ethical considerations while developing PCB's.

Catalogue prepared by	Mrs. ARUNA M
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3129	**Course Title: Digital Control System** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**Fundamental knowledge of Differential Equations, Laplace transforms, Discrete time signals and Z-Transform.**					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to enable the students to understand the principles and significance of feedback and digital control systems design. The nature of the course is conceptual and analytical perception which will provide the students to be able to analyze a particular linear system. The concept of digital control system is used in various fields of Engineering like Petrochemical, Biomedical, and Robotics. The course will be aided by simulations, which will enable the students to validate their theoretical findings. The course will have several simulation assignments which will enhance the student's abilities to become a good digital control systems engineer.**					
Course Objectives	**The objective of the course is to familiarize the learners with the concepts of Digital Control System and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** (1)Describe various processes involved in digital control systems (2)Employ time domain specifications of digital control systems (3)Explain frequency domain specifications of digital control systems (4)Identify the need of State space approach					
Course Content:						
Module 1	Systems Modelling	Assignment/quiz	Programming Task	**12Sessions**		
Topics: **Basic elements in classical feedback in continuous control systems, Laplace transform to find transfer function of continuous control system, representation of digital controller from continuous control system using bilinear transformation discretization technique.**						
Module 2	Time Domain Specifications	Assignment/quiz	Programming task	**12 Sessions**		
Topics: **Time domain specifications, dynamic response to unit step and ramp functions, stability of discrete time systems, digital PID design, pole placement design**						
Module 3	Frequency domain specifications	Assignment/quiz	Programming task	**9 Sessions**		
Topics: **Frequency domain specifications, gain and phase margins, compensator design with bilinear transformation**						
Module 4	Digital control system through state space approach	Case study	Simulation task	**10 Sessions**		

Topics:
State space description of discrete systems; State feedback design via pole placement; State estimator design; Controller design with state estimator.

Targeted Application & Tools that can be used:

Application of this course is in the field of process control industries, automobile industries, aerospace etc.

1. **MATLAB/ SIMULINK**
2. **Octave**

Text Book(s):

1. GF Franklin, JD Powell and ML Workman, 'Digital Control of Dynamic Systems', 3rdEdition, Addison Wesley, 1998

Reference(s):

Reference Book(s):

1. Charles L. Philips and H. Troy Nagle 'Digital Control System Analysis and Design', Prentice Hall Englewood Cliffs, New Jersey, 3rdEdition

2. Constatine H. Houpisand Gary B. Lamont, 'Digital Control Systems Theory, Hardware, Software', Mc-Graw Hill Inc., New Delhi,2nd Edition

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-1-introduction-and-basic-concepts/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-2-discrete-time-dt-systems/

E-content:

17. M. Phister, "Digital Control Systems-Present and Future," in IRE Transactions on Industrial Electronics, vol. PGIE-11, pp. 44-47, Dec. 1959, doi: 10.1109/IRE-IE.1959.5007732. https://ieeexplore.ieee.org/document/5007732
18. J. V. Wallbank, S. Singh and S. Walters, "An introduction to the implementation of digital control — Leading to the control of electrical power systems," 2017 52nd International Universities Power Engineering Conference (UPEC), 2017, pp. 1-5, doi: 10.1109/UPEC.2017.8232032. https://ieeexplore.ieee.org/abstract/document/8232032
19. V. Dimitrov, N. Hinov and K. Genev, "Synthesis and Implementation of a Digital Control System for a Buck DC-DC Converter," 2021 29th National Conference with International Participation (TELECOM), 2021, pp. 161-166, doi: 10.1109/TELECOM53156.2021.9659658. https://ieeexplore.ieee.org/document/9659658
20. S. V. Bell, T. M. Murray and K. T. Duncan, "Design of direct digital control systems for building control and facilities management," IEEE Proceedings of the SOUTHEASTCON '91, 1991, pp. 674-676 vol.2, doi: 10.1109/SECON.1991.147841. https://ieeexplore.ieee.org/document/147841

Catalogue prepared by	Mrs. Priyanka Ray
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3130	**Course Title: Electromagnetic Theory and Transmission Lines** **Type of Course: Discipline Elective-VLSI and Embedded systems Design Basket**	**L-P-C**	3	0
Version No.	1.0			
Course Pre-requisites	Basic concepts of engineering mathematics and engineering physics			
Anti-requisites	**NIL**			
Course Description	**This course imparts knowledge to explore numerous technological and scientific applications such as electric generators, electric motors, electrical appliances, electric bells and MRI scanning etc. This course gives a comprehensive coverage of a wide variety of real-life applications related to numerous communication systems. The purpose of this course is to enable the students to realize the operating principles of electromagnetic field, understand the behavior of light and its nature. The course also enable the students to discuss wave propagation in various lossy and lossless transmission lines.**			
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**			
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Define** the difference between scalars and vector fields and coordinate systems 2) **Solve** problems in simple geometries using separation of variables 3) **Derive** the expressions for energy both for the electrostatic and magneto static fields from Maxwell's equations 4) **Select** the appropriate transmission lines for specific applications			
Course Content:				
Module 1	**Vector algebra and Coordinates systems**	Quiz	Memory Recall based Quizzes	**12 session**
Topics: Scalrs and vectors, unit vector, vector addition and subtraction, position and distance vector, vector multiplication, components of a vector, Cartecian coordinates, circular cylindrical coordinates, spherical coordinates				
Module 2	**Electrostatic fields**	Assignment / Quiz	Programming task	**10 session**
Topics: Coulomb's law and field intensity, electric fields due to continuous charge distribution, electric flux density, Gauss's law, applications of Gauss's law, electric potential, relationship between E and V, an electric dipole and flux lines, energy density in electrostatic fields				
Module 3	**Magnetostatics fields and Maxwell's equations**	Assignment	Memory Recall based Quizzes	**10 session**

Topics:
Biot-savart's law, Ampere's circuital law, applications of Ampere's law, magnetic flux density. Maxwell's equation in integral form and differential form

Module 4	**Transmission Lines**	Assignment	Programming task	**11 session**

Topics:
Introduction, transmission line general solution, the infinite line, distortion less line, open and short circuited lines, reflection factor, reflection loss, insertion loss, transmission line parameters.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Application Area is low and high frequency magnetic field generation application to power electronics and communication systems.

Professionally Used Hardware/Software: Arduino/Raspberry Pi , MATLAB/SIMULINK/Arduino/Python

Project Work/Assignment:

Assignment-1: Generation of magnetic field in helical and spiral copper coil of required turns to pass current of 10A with DC source
Assignment-2: Generation of magnetic field in helical and spiral copper coil of required turns and frequency to pass current of 10A with AC source
Assignment-3: Implementation of magneto meter to measure the magnetic field intensity using Arduino controller and hall sensor A1324LUAT and display the results on LCD
Assignment-4: Implementation of magneto meter to measure the magnetic field intensity using Arduino controller and hall sensor UGN3503U and display the results on LCD
Assignment-5: Implementation of magneto meter to measure the magnetic field intensity using Arduino controller and HMC5883 and display the results on LCD
Assignment-6: Implementation of magnetic levitation using Leviation coil, hall sensor and Arduino controller
Assignment-7: Implementation of magnetic levitation using electromagnet 12v 25mm diameter, linear hall sensor 49E and Arduino controller
Assignment-8: Transmission line parameters measurement for 100m Flexible RG174 Coax Extension Cable Single Shielded with PVC Jacket

Text Book(s):

17. Matthew N. O. Sadiku, "Elements of Electromagnetics" Oxford University Press
18. K. Giridhar, "Transmission Lines and Wave Guides", Pooja Publications, India

Reference(s):
Reference Book(s):

1. Pramanik, Ashutosh, "Electromagnetism – Theory and Applications", Prentice-Hall of India Private Limited.n
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 200

Online Resources (e-books, notes, ppts, video lectures etc.):

12. Video Lecture on Electomagnetic Theory https://youtube.com/playlist?list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT
13. Topics on Radio wave Engineering https://www.sciencedirect.com/topics/engineering/radio-wave
14. Topics on Wave propagation https://www.sciencedirect.com/topics/physics-and-astronomy/wave-propagation

15. Lecture notes on Electomagnetic Theory https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring-2004/pages/lecture-notes/
16. Lecture notes on Electomagnetic Theory https://www.slideshare.net/kumar_vic/electromagnetic-theory
17. Topics on Electomagnetic Theory https://www.sciencedirect.com/topics/computer-science/electromagnetic-theory#:~:text=Electromagnetic%20theory%20based%20on%20Maxwell's,law%20of%20reflection%20in%20optics.

E-content:

23. Y. Jinni and K. N. Minhad, "Report on Electromagnetic Field Theory and Waves," 2020 International Signal Processing, Communications and Engineering Management Conference (ISPCEM), Montreal, QC, Canada, 2020, pp. 232-239, doi: 10.1109/ISPCEM52197.2020.00054. https://ieeexplore.ieee.org/document/9480976
24. R. S. Elliott, "Electromagnetic Theory: A Simplified Representation," in IEEE Transactions on Education, vol. 24, no. 4, pp. 294-296, Nov. 1981, doi: 10.1109/TE.1981.4321515. https://ieeexplore.ieee.org/abstract/document/4321515
25. L. L. Spada and Y. Hao, "Electromagnetic waves control for antennas applications," 2017 IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), Verona, Italy, 2017, pp. 116-119, doi: 10.1109/APWC.2017.8062256. https://ieeexplore.ieee.org/document/8062256
26. J. R. Carson, "Electromagnetic theory and the foundations of electric circuit theory," in The Bell System Technical Journal, vol. 6, no. 1, pp. 1-17, Jan. 1927, doi: 10.1002/j.1538-7305.1927.tb00189.x. https://ieeexplore.ieee.org/document/6773172
27. F. K. Kirsten, "Transmission Line Design," in Transactions of the American Institute of Electrical Engineers, vol. XXXVI, pp. 735-788, January-December 1917, doi: 10.1109/T-AIEE.1917.4765500. https://ieeexplore.ieee.org/document/4765500

Topics related to development of "FOUNDATION": Scalrs and vectors, unit vector and operations
Topics related to development of "EMPLOYABILITY": Electostatics and Magnetostatics
Topics related to development of "ENTREPRENEURSHIP": Applications of Electromagnetics and transmission lines
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Electric fields and magnetic fields
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Ethical considerations while constructing electromagnetic wave generation systems and transmission lines .

Catalogue prepared by	Dr. Sreenivasappa B V
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code: ECE3131</td><td colspan="4">Course Title: Analog and Digital Communication
Type of Course: Discipline Elective- VLSI and Embedded Systems Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">This course explores the fundamentals of electronic communication systems. The course has two primary focuses:
(1) Understanding Analog communications systems with design and analysis of various basic modulation systems.
(2) Understanding Digital communications systems with design and analysis of various basic Digital modulation systems.</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">The purpose of this course is to enable the students need to learn basic concepts of analog and digital communication, components of Analog and Digital Communication systems, Advantages and disadvantages of Analog and Digital communication systems.</td></tr>
<tr><td>Course Objective</td><td colspan="9">This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
1) Describe about the amplitude modulation techniques.
2) Understand about the modulation techniques used for digital data transmission.
3) Illustrate the angle modulation techniques.
4) Apply the knowledge about the digital communication.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="3">Amplitude Modulation:</td><td colspan="2">Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>12 session</td></tr>
<tr><td colspan="10">Topics:
Principles of amplitude modulation - AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM power distribution, AM modulator circuits low level AM modulator, medium power AM modulator, AM transmitters – Low level transmitters, high level transmitters, receiver parameters, AM reception – AM receivers – TRF, super heterodyne receiver, double conversion AM receivers.</td></tr>
<tr><td>Module 2</td><td colspan="3">Angle Modulation</td><td colspan="2">Assignment / Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>12 session</td></tr>
<tr><td colspan="10">Topics:
Angle modulation - FM and PM waveforms, phase deviation and modulation index, frequency deviation, phase and frequency modulators and demodulators, frequency spectrum of Angle – modulated waves. Average power of an angle-modulated wave, frequency and phase modulators, A direct FM transmitters, Indirect transmitters, Angle modulation Vs amplitude modulation,
FM receivers: FM demodulators, PLL FM demodulators, FM noise suppression, frequency verses phase modulation.</td></tr>
<tr><td>Module 3</td><td colspan="3">Digital Transmission And Data Communication</td><td colspan="2">Assignment</td><td colspan="2">Memory Recall based Quizzes</td><td>10 session</td></tr>
<tr><td colspan="10">Topics:
pulse modulation, PCM – PCM sampling, sampling rate, signal to quantization noise rate, companding – analog and digital – percentage error, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission – ISI, eye pattern. Modulation techniques for ASK,FSK, PSK, MSK, BPSK, QPSK, GMSK</td></tr>
</table>

Module 4	Spread Spectrum And Multiple Access Techniques	Assignment	Memory Recall based Quizzes	**09 session**

Topics:
Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques – wireless communication, TDMA and FDMA, wireless communication systems, source coding of speech for wireless communications.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

1. Virtual Lab by IIT Bombay.
2. MATLAB ,SCILAB ,LABVIEW
3. Various Analog and Digital Communication Trainers
4. Data compression.
5. Channel coding.
6. Equalization

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment: - Implementation of various concepts in from modulation/demodulation techniques on MATLAB

Text Book(s):

19. Wayne Tomasi, "Electronic Communication Systems: Fundamentals Through Advanced", Pearson Education, 2001. (UNIT I-IV Chapters- 3,4,6,7,12,13,15).

20. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons., 2001. (Unit V Chapters- 7,8).

Reference(s):

Reference Book(s):

1. "Electronic Communication Systems", Thomson Delmar Publications, 2002.
2. Martin S.Roden, "Analog and Digital Communication System", 3rd Edition, PHI, 2002.
3. Digital and analog communication system by B.P.Lathi .Zhi Ding 4th edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

18. Ebook :- https://www.mangoud.com/EENG373_files/Book-Sklar.pdf
19. NPTEL online video content:- https://nptel.ac.in/courses/117101051
20. Online ppts :- https://iare.ac.in/sites/default/files/PPT/AC%20PPTs_0.pdf
21. Online notes: https://www.researchgate.net/publication/340916217_Digital_and_Analog_Communication
22. https://presiuniv.knimbus.com/user#/home

E-content:

1. Chunmei Li; Zheng Dou; Guangzhen Si; Meiyu Wang "A Novel Digital-Analog Integrated Communication System Based on the PARATUCKMode

"https://ieeexplore.ieee.org/communication/stamp.sp?tp=&arnumber=9294028 2.Sophia V. Tikhonova; Denis S. Artamonov; Marina L. Volovikova "Professional Communication of a Historian in the Digital Society" https://ieeexplore.ieee.org/document/9101312 3. George Papageorgiou; Stelios Marneros; Andreas Efstathiades "Social Media as a Digital Communications Strategy; the Case of Hotel Enterprises in Cyprus" https://ieeexplore.ieee.org/document/9101261	
Topics related to development of "FOUNDATION": Principles of amplitude modulation Topics related to development of "EMPLOYABILITY": wireless communication systems Topics related to development of "ENTREPRENEURSHIP": AM transmitters	
Catalogue prepared by	Ms Akshatha K
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3133	**Course Title: Semiconductor Device Modeling** **Type of Course: Discipline Elective, General Basket** **Theory only**		**L-T-P-C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**Engineering Physics, Electron devices**				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to enable the students to understand the theoretical concepts of various semiconductor devices. The course also demonstrates the use of Cadence / Micro wind / other EDA tools to design various circuit designs for different applications.**				
Course Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using VLSI Design Tools.**				
Course Outcomes	**On successful completion of this course, the students shall be able to:** 1) **Describe** the properties of MOS capacitors 2) **Understand** the various characteristics of the MOSFET device 3) **Illustrate** the design of CMOS design parameter and their impact on its performance 4) **Analyze** the various SPICE models of semiconductor devices				
Course Content:					
Module 1	**MOS capacitors**	Quiz	Memory Recall-based Quizzes	**12 sessions**	
Topics: Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in a MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling.					
Module 2	**MOSFET devices**	Assignment / Quiz	Memory Recall-based Quizzes	**12 sessions**	
Topics: Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances, and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields.					
Module 3	**CMOS device design**	Assignment	Simulation task	**12 sessions**	
Topics: CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel					

Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

Module 4	**SPICE Models**	Assignment	Memory Recall-based Quizzes	**09 sessions**

Topics:
SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2, and Level 3 model, Model parameters; SPICE models of p-n diode and BJT.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: control applications, telecommunications, high-performance computing, and consumer electronics etc.
Professionally Used Software: Cadence, Microwind, and other EDA tools

Project Work/Assignment:

1. Quiz: At the end of the course quiz topic will be given to individual students. They need to do it CAMU online portal.
2. Project Assignment: - Implementation of various design in Nonscaling using EDA tools.

Text Book(s):

21. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
22. 2. A.B. Bhattacharyya "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd, 2009.

Reference(s):
Reference Book(s):

23. C. C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson Education, 2010.
24. R. S. Muller and T. I. Kamins, Device Electronics for Integrated Circuits, 3rd Edition, Wiley India, 2009.
25. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, 3rd Edition, Wiley India, 2010.
26. Y. Tsividis, Operation and Modeling of the MOS transistor, 2nd Edition, TMH, 1999.
27. S. A. Neamen and D. Biswas, Semiconductor Physics and Devices, 4th Edition, TMH, 2012.

Online Resources (e-books, notes, ppts, video lectures etc.):

23. Free online self-paced course:- https://www.classcentral.com/course/youtube-electronics-semiconductor-device-modeling-47587
24. Online notes:- https://www.tutorialsduniya.com/notes/semiconductor-devices-notes/
25. NPTEL online video content:- https://nptel.ac.in/courses/117106033
26. Online ppts:- https://www.slideserve.com/anneke/modelling-simulation-of-semiconductor-devices
27. https://presiuniv.knimbus.com/user#/home

E-content:

28. Manikandan, M., Nirmal, D., Ajayan, J., Arivazhagan, L., Prajoon, P., Dhivyasri, G., Jagadeeswari, M. "Physics based modeling of AlGaN/BGaN quantum well based ultra violet light emitting diodes" (2022) Optical and Quantum Electronics, 54 (3), art. no. 168. https://link.springer.com/article/10.1007/s11082-022-03552-8
29. Ajayan, J., Nirmal, D., Kurian, D., Mohankumar, P., Arivazhagan, L., Augustine Fletcher, A. S., ... & Saravanan, M. (2019). Investigation of impact of gate underlap/overlap on the analog/RF performance of composite channel double gate MOSFETs. Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena, 37(6), 062201.

https://pubs.aip.org/avs/jvb/article-abstract/37/6/062201/103400/Investigation-of-impact-of-gate-underlap-overlap?redirectedFrom=fulltext
30. Lenus, C. R., Haris, M., Rani, C. S. H., Samuel, T. A., & Ajayan, J. (2023). A Non-linear Circuit Model for Silicon Tunnel Field-Effect Transistors. Journal of Electronic Materials, 1-8. https://link.springer.com/article/10.1007/s11664-023-10447-1
31. Nirmal, D., & Ajayan, J. (2022). Negative Capacitance Field Effect Transistors for Future Low Power Electronics. In Low-Dimensional Nanoelectronic Devices (pp. 317-350). Apple Academic Press. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003277378-12/negative-capacitance-field-effect-transistors-future-low-power-electronics-nirmal-ajayan

- Topics related to the development of "FOUNDATION": Surface Potential, Capacitances in a MOS Structure.
- Topics related to the development of "EMPLOYABILITY": Extraction of Channel Length by C–V Measurements, SPICE model.

Catalogue prepared by	**Dr. M.Manikandan**
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3135	**Course Title: Synthesis and Optimization of Digital Circuits** **Type of Course: General Basket** **Theory only**	**L-P-C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**Basics of** Graph theory, Boolean Algebra and abstract algebra, Combinatorial and sequential circuits .				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to provide students with a comprehensive understanding of the principles techniques and algorithms for synthesis and optimization of digital systems. Topics in synthesis cover high-level and architectural synthesis, decision and HDLs, combinational logic optimization, and sequential optimization.**				
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Understand** the principles and techniques of digital circuit synthesis and optimization. **2. Apply** various synthesis algorithms to design and optimize digital circuits**.** **3. Design** digital circuits using hardware description languages (HDLs) and synthesis tools. **4. Evaluate** the trade-offs between different optimization strategies and select the most appropriate approach for a given design goal.				
Course					

Content:				
Module 1	Introduction to Synthesis and Optimization of Digital Circuits	Quiz	Memory Recall based Quizzes	**12 session**
Topics: Microelectronics, semiconductor technologies and circuit taxonomy, Microelectronic design styles, Computer aided synthesis and optimization, Graphs: Notation, undirected graphs, directed graphs, Combinatorial optimization, Algorithms, Tractable and intractable problems ,Algorithms for linear and integer programsGraph optimization problems and algorithms, Boolean algebra and Applications.				
Module 2	**Hardware Modeling**	Assignment / Quiz	Programming task	**12 session**
Topics: Hardware Modeling Languages,Distinctive features,Structural hardware language,Behavioral hardware language,HDLs used in synthesis. abstract models,structures logic networks,state diagrams,data flow and sequencing graphs,compilation and optimization techniques.				
Module 3	**Two Level Combinational Logic Optimization**	Assignment	Memory Recall based Quizzes	**10 session**
Topics: Logic optimization principles,operation on two level logic covers,Algorithms for logic minimization,Symbolic minimization and encoding property,Minimization of Boolean relations.				
Module 4	**Sequential Circuit Optimization**	Assignment	Programming task	**09 session**
Topics: Sequential circuit optimization using state based models, Sequential circuit optimization using network models, Fundamental Mode sequential Circuit Optimization, Schedule Algorithms: A model for scheduling problems, Scheduling with resource and without resource constraints, Scheduling algorithms for extended sequencing.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: **Targeted Applications:** Low power Vlsi Circuits, ASICs, FPGAs, Embedded Systems. Professionally Used Software: 1. Cadence Allegro 2. Synopsys Design Compiler 3. Xilinx Vivado 4. Mentor Graphics PADS 5. Altium Designer				
Project Work/Assignment:				
1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format. **3. Presentation:** There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. **4. Project Assignment: -** Implementation of various concepts from Synthesis and hardware modeling.				
Text Book(s): 23. Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits", Tata McGraw-Hill, 2003.ISBN 13: 9780070582781				

Reference(s):

Reference Book(s):

28. SrinivasDevadas, AbhijitGhosh, and Kurt Keutzer, "Logic Synthesis", McGraw-Hill, USA, 1994.ISBN:0-07-016500-9
29. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective," 2ndedition, Pearson Education (Asia) Pte. Ltd., 2000.ISBN-13: 978-0321547743
30. Kevin Skahill, "VHDL for Programmable Logic," Pearson Education (Asia) Pvt. Ltd., 2000.ISBN-13: 978-0201895735

Online Resources (e-books, notes, ppts, video lectures etc.):

28. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc19_cs73/preview
29. Online ppts :- http://web.cecs.pdx.edu/~mperkows/CLASS_VHDL_99/IntroEDA-Tools.pdf
30. https://presiuniv.knimbus.com/user#/home

E-content:

32. S. Yamashita, H. Sawada and A. Nagoya, "A new method to express functional permissibilities for LUT based FPGAs and its applications", International Conference on Computer Aided Design (ICCAD), pp. 254-261, Nov. 1996. https://ieeexplore.ieee.org/document/569635
33. S. Sinha and R. K. Brayton, "Implementation and use of SPFDs in optimizing Boolean networks", International Conference on Computer Aided Design (ICCAD), pp. 103-110, Nov. 1998. https://ieeexplore.ieee.org/document/742858
34. Ching-Yi Huang, Chih-Jen Hsu, Chi-An Wu and Kei-Yong Khoo, "ICCAD-2017 CAD contest in resource-aware patch generation", International Conference on Computer Aided Design (ICCAD), Nov. 2017. https://ieeexplore.ieee.org/document/8203868
35. Masahiro Fujita, "Toward Unification of Synthesis and Verification in Topologically Constrained Logic Design", Proceedings of the IEEE, vol. 103, no. 11, pp. 2052-2060, 2015. https://ieeexplore.ieee.org/document/7287741

Topics related to development of "FOUNDATION": Microelectronic design styles, Computer aided synthesis and optimization
Topics related to development of "EMPLOYABILITY": Scheduling algorithms for extended sequencing models,Scheduling Pipe lined circuits.
Topics related to development of "ENTREPRENEURSHIP":

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3136	**Course Title: VLSI Wireless Communication Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Basic concepts on Communication system, Wireless communication,** VLSI Design				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to enable the students to understand the acquire knowledge on Modulation techniques, Spread Spectrum, Receiver Architecture, Low Noise Amplifier, Analog to Digital Converters & Synthesizer and VLSI architecture for Wireless Systems,**				
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Narrate** different Modulation techniques, Spread Spectrum and Receiver Architecture 2. **Analyze** the concepts of Low Noise Amplifier, Analog to Digital Converters & Synthesizer and VLSI architecture for Wireless Systems. 3. **Demonstrate** the knowledge of Low Noise Amplifier - Matching Networks 4. **Analyze** Efficient VLSI Architecture for Base Band Signal processing				
Course Content:					
Module 1	**Communication Concepts**	Quiz	Memory Recall based Quizzes		**12 session**
Topics: Review of Modulation Schemes - BFSK- BPSK -QPSK - OQPSK - Classical Channel - Additive White Gaussian Noise - Finite Channel Bandwidth - Wireless Channel - Path Environment - Path Loss - Friis Equation - Multipath Fading - Channel Model - Envelope Fading - Frequency Selective Fading - Fast Fading - Comparison of different types of Fading- Review of Spread Spectrum - DSSS - FHSS - Principle of DSSS - Modulation - Demodulation - Performance in the presence of noise - narrowband and wideband interferences.					
Module 2	**RECEIVER ARCHITECTURE**	Assignment / Quiz	Programming task		**12 session**
Topics: Receiver Front End - Motivations - General Design Philosophy- Heterodyne and Other architectures - Filter Design - Band Selection Filter - Image Rejection Filter - Channel Filter - Non idealities and Design Parameters - Harmonic Distortion - Intermodulation - Cascaded Nonlinear Stages - Gain Compression - Blocking - Noise - Noise Sources - Noise Figure - Design of Front end parameter for DECT.					
Module 3	**LOW NOISE AMPLIFIER**	Assignment	Memory Recall based Quizzes		**10 session**
Topics: Low Noise Amplifier - Matching Networks - Matching for Noise and Stability - Matching for Power - Implementation - Comparison of Narrowband and Wideband LNA - Wideband LNA					

Design - Narrowband LNA - Impedance matching -Power matching- Salient features of LNA - Core Amplifier Design.

Module 4	**VLSI ARCHITECTURE FOR WIRELESS SYSTEMS**	Assignment	Programming task	**09 session**

Topics:
Implementations: VLSI architecture for Multi-tier Wireless System - Hardware Design Issues for a Next generation CDMA System - Efficient VLSI Architecture for Base Band Signal processing.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Hardware Design for a Next generation CDMA System, Accessing the Internet, Locating and Tracking-GPS

Professionally Used Software: Arduino, Matlab integration with GSM receiver, integrate the GSM device with any microcontroller, the embedded programming, SMS gateway simulator which can be used for testing purpose.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Assignment: -

(i) Explain qualitatively that in a frequency synthesizer, when we want to select a new channel via changing the divider ratio, initially the loop will not track, but eventually it will track.

(ii) Suppose we want to go for a fixed fif (and hence a variable flo) scheme because this allows the use of a fixed frequency BPF2, which is easier to implement. We showed how, with this scheme, image can become a problem. A system designer suggests that we should instead use a variable fif, fix flo scheme, together with a fixed frequency BPF2 because he believes this will fix the problem. Is he correct? Assume that the receive band spans from 824 to 894 MHz.

(a) Assume that we use a fixed fif of 10 MHz and a variable flo. Draw the frequency spectrum, including all relevant frequencies, when frf is 894 and 824 MHz. Repeat the case for fif of 100 MHz.

(b) Now assume that we use a variable fif and a fixed flo of 760 MHz. Again, draw the spectrum when frf is 894 and 824 MHz. Repeat the case for flo of 850 MHz.

(c) Now determine the fimage for all the cases in (a) and (b) and comment on whether scheme (b) is better than scheme (a) as far as making it easier for BPF2 to filter out the image.

Text Book(s):

1. Bosco Leung, "VLSI for wireless Communication", Springer, 2nd Edition, 2011.

Reference(s):

Reference Book(s):

1. Andreas F.Molisch, "Wideband wireless Digital Communication", Prentice Hall PTR, 2001.
2. George.V.Tsoulous, "Adaptive Antennas for wireless Communication", IEEE Press, Willey Publications, 2001.
3. Xiaodong Wang and H.Vincent Poor, "Wireless Communication System, Advanced Techniques for Signal Reception", Pearson Education. 2004.
4. Wolfgang Eberle, "Wireless Transceiver Systems Design", Springer, 2008.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. **http://ndl.ethernet.edu.et/bitstream/123456789/17674/1/482.pdf**
2. **https://link.springer.com/book/10.1007/978-1-4614-0986-1**
3. **https://nptel.ac.in/courses/117105132**
4. **https://nptel.ac.in/courses/108105157**
5. **https://cse.engin.umich.edu/wp-content/uploads/2021/03/EECS_598_VLSI.pdf**

E-content:

1. A. Verma and R. Shrestha, "A New VLSI Architecture of Next-Generation QC-LDPC Decoder for 5G New-Radio Wireless-Communication Standard," 2020 IEEE International Symposium on Circuits and Systems (ISCAS), Seville, Spain, 2020, pp. 1-5, doi: 10.1109/ISCAS45731.2020.9181188. **https://ieeexplore.ieee.org/document/9181188**
2. V. Kumar, K. C. Ray and P. Kumar, "CORDIC-based VLSI architecture for implementing CI-OFDM and its FPGA prototype," 2016 International Conference on VLSI Systems, Architectures, Technology and Applications (VLSI-SATA), Bengaluru, India, 2016, pp. 1-5, doi: 10.1109/VLSI-SATA.2016.7593037. **https://ieeexplore.ieee.org/document/7593037**
3. S. Yoshizawa and Y. Miyanaga, "VLSI Implementation of a 600-Mbps MIMO-OFDM Wireless Communication System," APCCAS 2006 - 2006 IEEE Asia Pacific Conference on Circuits and Systems, Singapore, 2006, pp. 93-96, doi: 10.1109/APCCAS.2006.342304. **https://ieeexplore.ieee.org/document/4145340**
4. Hua-Chin Lee, Chin-Kae Tzou, Chorng-Kuang Wang and Viggen Dan, "A fast-acquisition demodulation scheme for 2.4 GHz wireless DSSS transceiver VLSI," 1999 International Symposium on VLSI Technology, Systems, and Applications. Proceedings of Technical Papers. (Cat. No.99TH8453), Taipei, Taiwan, 1999, pp. 227-230, doi: 10.1109/VTSA.1999.786041. **https://ieeexplore.ieee.org/document/786041**

Topics related to development of "FOUNDATION": Filter Design

Topics related to development of "EMPLOYABILITY": Hardware Design Issues for a Next generation CDMA System

Catalogue prepared by	Ms. Maitraiyee Konar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3137	**Course Title: Analog VLSI Design** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	3	0	0
Version No.	1.0					
Course Pre-requisites	**Fundamentals of electronics Engineering, Network theory.**					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to introduce analog circuits in integrated circuit using MOS transistors and to make them underst the Small signal characteristics of widely used amplifier topologies.**					
Course Objective	**This course is designed to improve the learner's EMPLOYABIL SKILLS by using PROBLEM SOLVING Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Understand** the fundamental principles and concepts of microelectronics. 2) **Design** basic microelectronic circuits, using industry-standard software t for simulation and optimization. 3)**Illustrate** various fabrication processes involved in the production microelectronic devices and integrated circuits. 4) **Apply** the microelectronics in real-world industries such telecommunications, consumer electronics, medical devices, and automo systems.					
Course Content:						
Module 1	**Fundamentals of Analog VLSI circuits.**	Quiz	Memory Recall based Quizzes			**12 sessi**

Topics:
Linearization of non-linear elements, Generation of small incremental linear equivalents from n
linear elements. Basic amplifier design using MOSFET. Common source amplifier with resistive l
Biasing a common source amplifier. Gain limitations of the configuration. Introduction to swing lin
Relevance of the limitations in an integrated circuit.

Module 2	**Biasing Techniques and Controlled sources.**	Assignment / Quiz	Programming task	**12 sessio**

Topics:
Different biasing techniques of a common source amplifier. Use of negative feedback to realize st
biasing. Distinction between constant voltage and constant current biasing. Introduction to contro
sources. Realizing controlled sources using a voltage controlled current source. Using MOSFET
realize the controlled sources and other amplifier configurations. Body effects in an MOSFET.
effect of output resistance of a MOSFET on an amplifier configuration.

Module 3	**Active Loads**	Assignment	Memory Recall based Quizzes	**10 sessi**

Topics:
Introduction to active loads, and single stage differential amplifiers. Analysis of gain,swing limits, s
rate, common mode rejection ratio, power supply rejection ratio in a single stage differential ampli

Module 4	**Amplifiers**	Assignment	Programming task	**09 sessio**

Topics:
Multi-stage amplifiers using controlled sources. Introduction of stability parameters of multist
amplifier when configured in negative feedback. Design and analysis of multi-stage amplifier
replacing the controlled sources with MOSFETs.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Nanotechnology, VLSI circuits, Amplifiers Design and MEMS.
Professionally Used Software: Cadence-Virtuoso.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a grou
students. They need to refer to the library resources and write a report on their understanding al
the assigned article in an appropriate format.
3. Presentation: There will be a group presentation, where the students will be given a topic. T
will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Implementation of various concepts from Analog VLSI circuits
Amplifiers.

Text Book(s):

24. Design of Analog CMOS Integrated Circuits, B. Razavi, McGraw-Hill, 2nd Edition, 2017.

Reference(s):
Reference Book(s):

1. J Analog Integrated Circuit Design, T. Chan Carusone, D. Johns and K. Martin, John Wiley & S
2nd Edition, 2011.
2. Analysis and Design of Analog Integrated Circuits, P. Gray, P. Hurst, S. Lewis, and R. Meyer, J
Wiley and Sons, 5th Edition, 2009.
3. Microelectronic Circuits, A. Sedra and K. Smith, Oxford University Press, 7th Edition, 2014.

Online Resources (e-books, notes, ppts, video lectures etc.):

31. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc23_ee142/preview
32. Online ppts :- Analog VLSI Design https://www.utdallas.edu/~zhoud/EE%207v88/lect%2016/Lect%20%2016%20final%20pro .ppt
33. https://presiuniv.knimbus.com/user#/home

E-content:

36. IEE Colloquium on 'VLSI Analogue Design' (Digest No.66) https://ieeexplore.ieee.org/document/198316
37. High performance analog VLSI computational circuits. https://ieeexplore.ieee.org/document/663572
38. An analog VLSI chip with asynchronous interface for auditory feature extrac https://ieeexplore.ieee.org/document/673642
39. Diagnosis of parametric faults in linear analog VLSI circ https://ieeexplore.ieee.org/document/7726995/

Topics related to development of "FOUNDATION": Basic amplifier design using MOSFET.
Topics related to development of "EMPLOYABILITY": Design and analysis of multi-stage amplifie replacing the controlled sources with MOSFETs.
Topics related to development of "ENTREPRENEURSHIP":

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3138	**Course Title: VLSI Interconnects** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Basic concepts of Digital Circuits and VLSI Design						
Anti-requisites	**NIL**						
Course Description	**This course introduces concepts of Interconnects are the wired connections between various devices and components in an integrated circuit. As the clock frequency and operating frequency of the electronic devices is increasing, going up to several GHz, the effects of this wired connection cannot be ignored anymore. In fact, the interconnect effects which include delays, timing jitters and cross-talk are expected to become bottleneck in further increase in the speed of electronic circuits. In this course we will investigate origin of several interconnect effects and explore techniques for electromagnetic and circuit modeling of these interconnect effects. The course is of importance for anyone interested in the high frequency circuit design and signal integrity issues in electronics and telecommunication industries.**						
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**						
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Describe** the basics of transmission line parameters of VLSI Interconnects. 2) **Understand** the concept of parasitic extraction. 3) **Illustrate** variants types of interconnects in VLSI Circuits. 4) **Understand** the concept of carbon nanotubes.						
Course Content:							
Module 1	**Fundamentals of VLSI interconnects**	Quiz	Memory Recall based Quizzes	**12 session**			
Topics: Preliminary concepts: Interconnects for VLSI applications, metallic interconnects, optical interconnects, superconducting interconnects, advantages of copper interconnects, challenges posed by copper interconnects, fabrication process, even and odd mode capacitances, miller theorem, transmission line equations, resistive interconnection as ladder network, propagation modes in microstrip interconnection, slow wave mode propagation, propagation delays.							
Module 2	**Parasitic extraction**	Assignment / Quiz	Programming task	**12 session**			
Topics: Parasitic extraction: Parasitic resistance, effect of surface/interface scattering and diffusion barrier on resistance, Capacitance: parallel-plate capacitance, fringing capacitance, coupling capacitance, methods of capacitance extraction, Inductance: self-inductance, mutual inductance, methods of inductance extraction, high frequency losses, frequency dependent parasitics, skin effect, dispersion effect.							
Module 3	**Future VLSI Interconnects**	Assignment	Memory Recall based Quizzes	**10 session**			
Topics: Future VLSI Interconnects: Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotubes, Graphene nanoribbons: system issues and challenges, material processing issues and challenges, design issues and							

challenges.

Module 4	Carbon nanotubes	Assignment	Programming task	09 session

Topics:
Quantum electrical properties: quantum conductance, quantum capacitance, kinetic inductance, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, electron scattering and lattice vibrations, electron mean free path, single-wall CNT and single layer GNR resistance model, multi-wall CNT and multi-layer GNR resistance model, transmission line interconnect models, performance comparison of CNTs, GNRs and copper interconnects.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Application: Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.
Professionally Used Software: Cadence design suite, VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.
2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment: - Implementation of various concepts of VLSI Interconnects using cadence.

Text Book(s):

25. Ashok K. , ”High-Speed VLSI Interconnects”, Goel, 2007

Reference(s):
Reference Book(s):

31. Y.S. Diamand , ”Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications”, , 2009.
32. H.S Philip Wong and Deji Akinwande, “Carbon nanotube and Graphene Device Physics”, 2011.

Online Resources (e-books, notes, ppts, video lectures etc.):

34. Free online self-paced course :- https://onlinecourses.nptel.ac.in/noc22_ee125/preview
35. Online notes :- http://vlsi-eda.cm.nctu.edu.tw/course/Interconnect_09Fall/syllabus.pdf
36. NPTEL online video content:- https://archive.nptel.ac.in/courses/108/105/108105187/

E-content:

40. K. S. Sainarayanan, J. V. R. Ravindra, K. T. Nath and M. B. Srinivas, "Coding for Minimizing Energy in VLSI Interconnects," 2006 International Conference on Microelectronics, Dhahran, Saudi Arabia, 2006, pp. 166-169, doi: 10.1109/ICM.2006.373293. https://ieeexplore.ieee.org/document/4243675
41. J. Kumar, M. K. Majumder, B. K. Kaushik, S. Dasgupta and S. K. Manhas, "Novel modeling approach for multi-walled CNT bundle in global VLSI interconnects," 2012 International Conference on Communications, Devices and Intelligent Systems (CODIS), Kolkata, India, 2012, pp. 476-479, doi: 10.1109/CODIS.2012.6422242. https://ieeexplore.ieee.org/document/6422242
42. Z. Chen, "Enhancing Interconnect Reliability and Performance by 2D Materials," 2020 International Symposium on VLSI Technology, Systems and Applications (VLSI-TSA), Hsinchu, Taiwan, 2020, pp. 136-136, doi: 10.1109/VLSI-TSA48913.2020.9203726.

https://ieeexplore.ieee.org/document/9203726
43. P. K. Das, M. K. Majumder, B. K. Kaushik and S. Dasgupta, "Analysis of propagation delay in mixed carbon nanotube bundle as global VLSI interconnects," 2012 Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics, Hyderabad, India, 2012, pp. 118-121, doi: 10.1109/PrimeAsia.2012.6458638. https://ieeexplore.ieee.org/document/6458638

Topics Relevant to development of "FOUNDATION SKILLS": Parasitic Extraction
Topics Relevant to development of "EMPLOYABILITY": Carbon Nano Tubes.

Catalogue prepared by	Mr. V S VIJAYA KRISHNA V
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3140	**Course Title: Static Timing Analysis** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of Digital Circuits, VLSI Design					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to enable the students to understand the theoretical concepts of timing analysis in digital circuits. Static Timing Analysis is one of the important processes in ASIC design flow. By performing Static Timing Analysis, the designer can ensure that the design is meeting the timing requirements and it is working at the required clock frequency without setup and hold time violations.**					
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Describe** the basics of static timing analysis 2) **Understand** the resources required for static timing analysis 3) **Illustrate** variants of noise and cross talk 4) **Apply** the timing analysis concepts in real time circuits.					
Course Content:						
Module 1	**Fundamentals of Timing analysis**	Quiz	Memory Recall based Quizzes	**12 session**		
Topics: Basics of timing concepts- Propagation delay, slew, timing arcs, min and max timing paths, clock domains, Types of Delays in Digital Circuits, Different Cause for Delay, Timing Parameters for Combinational Logic Gates, Timing Parameters for Sequential Circuits, Concept of Delay Path in a Design, Clock Concepts, timing path groups, modeling of external attributes, virtual clocks, refining the timing analysis, point-to-point specification						
Module 2	**Resources for Static Timing Analysis**	Assignment / Quiz	Programming task	**12 session**		
Topics: Resources for Static Timing Analysis Flow: Libraries, Netlist, Parasitics for Delay Calculation: Device Parasitics, Interconnects, Parasitic Extraction Formats, linear v/s. non-linear delay model. Clock Network Optimization: Metrics, clock skew-scheduling, handling variability. Parallel Timing Optimization: Circuit partitioning for independent timing regions. Post-Silicon Timing Validation: Introduction, sources of post-silicon timing failure, post-silicon tuning						
Module 3	**Noise and Cross talk**	Assignment	Memory Recall based Quizzes	**10 session**		
Topics: Concepts of Noise and Crosstalk for static timing Analysis: Coupling Capacitance Concept, Type of Crosstalk Noise or Glitch, Types of Crosstalk Delta Delay, Noise Libraries, Crosstalk Effect on Timing Analysis, Strategy of Crosstalk on Nanometer Design: Cause for Crosstalk on Integrated Circuits, Crosstalk Prevention Methods						
Module 4	**Constraints of STA**	Assignment	Programming task	**09 session**		
Topics: Constraints for STA: Clock Constraints, Other Timing Constraints, 5.2.2 External Delays of DUA, Timing Exceptions: Multicycle Path, False Path, Clock Grouping, Case Analysis, Disable						

Timing, Path with Derate

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Application: Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.

Professionally Used Software: Cadence design suite, VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment: - Implementation of various concepts of timing analysis using cadence.

Text Book(s):

26. R.Jayagowri, Pushpendra S. Yadav, "Static Timing Analysis for VLSI circuits", MEDTECH, A Division of Scientific International, 2018.

27. J. Bhasker, R. Chadha, "Static Timing Analysis for Nanometer Designs: A Practical Approach", Springer, 2009, ISBN: 978-0-387-93819-6, 978-0-387-93820-2(e-book)

Reference(s):

Reference Book(s):

33. Sridhar Gangadharan and Sanjay Churiwala, "Constraining Designs for Synthesis and Timing Analysis - A Practical Guide to Synopsys Design Constraints (SDC)",Springer Science + Business Media, LLC, Library of Congress Cataloging-in-Publication Data, 2013, ISBN:978-1-4614-3268-5, 978-1-4614-3269-2 (eBook).

34. Jeong T.K, David O, "Digital Timing Macro modeling for VLSI Verification", Springer Science + Business Media, LLC, Library of Congress Cataloging-in-Publication Data, 1995, ISBN: 978-1-4613-5982-1, 978-1-4615-2321-5 (eBook).

35. Naresh Maheshwari and Sachin S. Sapatnekar, "Timing Analysis and Optimization of Sequential Circuits", Springer Science + Business Media, LLC, Library of Congress Catalogingin-Publication Data, 1999, ISBN:978-1-4613-7579-1, 978-1-4615-5637-4 (eBook).

Online Resources (e-books, notes, ppts, video lectures etc.):

37. Free online self-paced course :- https://open.cs.uwaterloo.ca/static analysis-from-scratch/
38. Online notes :- https://open.cs.uwaterloo.ca/timinganalysis-independent-lessons/
39. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106117202/L02.html
40. Online ppts :- https://cs.antloo.ca/~mli/vlsi-static-2017-Lecture5timing.ppt
41. Online ppts:- https://www.ucns.hw.ac.uk/~dwcorne/Timing/introdl.ppt
42. https://presiuniv.knimbus.com/user#/home

E-content:

44. E. Hu, G. Bernat and A. Wellings, "A static timing analysis environment using Java architecture for safety critical real-time systems," Proceedings of the Seventh IEEE International Workshop on Object-Oriented Real-Time Dependable Systems. (WORDS 2002), San Diego, CA, USA, 2002, pp. 77-84, doi: 10.1109/WORDS.2002.1000039. https://ieeexplore.ieee.org/document/1000039

45. X. Zhou, Y. Zhou and Y. Ma, "Static Error Mechanism Analysis and Simulation Research Based on PI Control," 2019 IEEE International Conference on Mechatronics and

Automation (ICMA), Tianjin, China, 2019, pp. 58-63, doi: 10.1109/ICMA.2019.8816554.
https://ieeexplore.ieee.org/document/8816554
46. Jin Wook Kim, Wook Kim, H. S. Park and Young Hwan Kim, "Incremental statistical static timing analysis with gate timing yield emphasis," APCCAS 2008 - 2008 IEEE Asia Pacific Conference on Circuits and Systems, Macao, China, 2008, pp. 1016-1019, doi: 10.1109/APCCAS.2008.4746197.
https://ieeexplore.ieee.org/document/4746197
47. Y. Shi, H. Bağcı and M. Lu, "On the Static Loop Modes in the Marching-on-in-Time Solution of the Time-Domain Electric Field Integral Equation," in IEEE Antennas and Wireless Propagation Letters, vol. 13, pp. 317-320, 2014, doi: 10.1109/LAWP.2014.2305716.
https://ieeexplore.ieee.org/document/6737267

Topics Relevant to development of "FOUNDATION SKILLS": Delay models and types.
Topics Relevant to development of "EMPLOYABILITY": Timing constraints.

Catalogue prepared by	Mr. V S Vijaya Krishna V
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3141**	**Course Title: Mixed Signal Design** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L-T-P-C**	**3**	0	0	3
Version No.	1.0					
Course Pre-requisites	**Analog Electronics, Linear Integrated Circuits, VLSI Design**					
Anti-requisites	**NIL**					
Course Description	The course aims to provide students the exposure to mixed sign design techniques in integrated context. Designs that combine analog circuits with digital signal processing, DSP, are called mixed-signal designs, MSDs					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Describe the basic of signals, filters and tools, sampling and aliasing effect in DSP system. 2. Develop the analog and digital filters 3. Understand the effect of noise and signal to noise ratio in the mixed signal design. 4. Describe the data converter using the MSD techniques and its associated trade-offs.					
Course Content:						
Module 1	**Signals, Filters, and Tools, Sampling and Aliasing**	Quiz	Memory Recall based Quizzes	**12 session**		
Sinusoidal signals, Comb Filters, Representation of signals (Fourier series and transform and dirac delta function), Sampling and aliasing: impulse sampling, decimation, sample and hold, interpolation, implementation of sample and hold circuits, Discrete analog integrator						
Module 2	**Analog and Digital Filters**	Assignment / Quiz	Programming task	**11 session**		
Analog Filter: Integrator Building Blocks- Low pass Filters,Active-RC Integrators, MOSFET-C Integrators, Discrete-Time Integrators, Filtering Topologies- The Bi-linear Transfer Function, Bi-quadratic Transfer Function Digital Filters: SPICE Models for DACs and ADCs, Sinc-Shaped Digital Filters, Bandpass and Highpass Sinc Filters, Interpolation using Sinc Filters, Filtering Topologies:FIR Filters-Stability and Overflow, The Bi-linear Transfer Function, Bi-quadratic Transfer Function						
Module 3	**Data Converter SNR and Data Converter Design Basics.**	Assignment	Memory Recall based Quizzes	**12 session**		
Data Converter SNR: Quantization Noise, Signal-to-Noise Ratio (SNR) Improving SNR using Averaging, Using Feedback to Improve SNR. **Data Converter Design Basics:** Passive Noise-Shaping, Improving SNR and Linearity.						
Module 4	**Noise-Shaping Data Converters, Bandpass Data Converters, and High-Speed Data Converter.**	Assignment/QUIZ	Programming task	**10 session**		
Noise-Shaping Data Converters: First-Order Noise Shaping, Second-Order Noise-Shaping,.						

Noise-Shaping Topologies.
Bandpass Data Converters: Continuous-Time Bandpass Noise-Shaping, Switched-Capacitor Bandpass Noise-Shaping.
High-Speed Data Converter: The Topology, Practical Implementation.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Applications in various fields such as biomedical, optical, wireless networks, aerospace, and consumer products
Professionally Used Software: MATLAB/ Python, Cadence, Vivaldo

Project Work/Assignment:

1. Study of various sensors.

2. Book/Article review:
At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.

3. Presentation:
There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

3. Baker, R. Jacob. CMOS: mixed-signal circuit design. john Wiley & sons, 2nd edition, 2008.

Reference(s):
Reference Book(s):

7. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis & Design" 4th edition, 2019, TMH publication.
8. R. Jacob Baker, "CMOS circuit design, layout and simulation" 1st edition, 2018, john Wiley & sons
9. Rudy V. dePlassche, CMOS Integrated ADCs and DACs, Springer, Indian 1st edition, 2005.
10. Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1st edition, 1981.
11. Design of Analog filters by R. Schauman, Prentice-Hall 1990, 1st edition.
12. An introduction to Mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 2008.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Video lectures on "CMOS Analog VLSI Design"
https://www.digimat.in/nptel/courses/video/117101105/L01.html

4. Video lectures on "CMOS Mixed Signal VLSI Design" by Prof. Maryam Shojaei Baghini, and Prof. Dinesh Sharma , IIT Bombay.

https://www.youtube.com/playlist?list=PLLDC70psjvq5vtrb0EdII4xIKA15ec-Ij

E-content:

5. R. C. Frye, "Integration and electrical isolation in CMOS mixed-signal wireless chips," in Proceedings of the IEEE, vol. 89, no. 4, pp. 444-455, April 2001, doi: 10.1109/5.920577. https://ieeexplore.ieee.org/abstract/document/920577
6. Chen, Zhe, Huifeng Zhu, Erxiang Ren, Zheyu Liu, Kaige Jia, Li Luo, Xuan Zhang et al. "Processing near sensor architecture in mixed-signal domain with CMOS image sensor

of convolutional-kernel-readout method." IEEE Transactions on Circuits and Systems I: Regular Papers 67, no. 2 (2019): 389-400. https://ieeexplore.ieee.org/abstract/document/8835152
7. Aishwaraya, H. R., Saroja V. Siddamal, Aishwaraya Shetty, and Prateeksha Raikar. "Verifying Mixed Signal ASIC Using SVM." In Advances in Computing and Network Communications: Proceedings of CoCoNet 2020, Volume 1, pp. 167-173. Springer Singapore, 2021. https://link.springer.com/chapter/10.1007/978-981-33-6977-1_14
8. Maheshwari, Sudhanshu. "Logic functions for mixed signal circuit design using analog block." Australian Journal of Electrical and Electronics Engineering 19, no. 3 (2022): 300-305. https://www.tandfonline.com/doi/abs/10.1080/1448837X.2022.2049052

Topics related to development of "FOUNDATION": Representing Signals, Sampling and Aliasing

Topics related to development of "SKILL":Analog Filters: Lowpass filters, Mosfet-C integrator,Filtering Topologies, Digital Filters: ADC, lkowpass, bandpass and highpass filters, Data Converter Design Basics,

Topics related to development of "EMPLOYABILITY": Data Converter SNR, Noise-Shaping Data Converters, Noise-Shaping Data Converters, A High-Speed Data Converter

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE3146</td><td colspan="3">Course Title: Hardware Platforms for AI/ML Deployment
Type of Course: Discipline Elective-VLSI and Embedded Systems Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8"></td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The purpose of this course is to introduce the students to the various facets of hardware for machine learning, including the fundamentals of deep learning, deep learning frameworks, hardware accelerators, co-optimization of algorithms and hardware, training and inference, and support for cutting-edge deep learning networks.</td></tr>
<tr><td>Course Objective</td><td colspan="8">This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PARTICIPATIVE LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
1) Describe the concept of model deployment on hardware
2) Describe the embedded hardware considerations for model deployment
3) Illustrate AI/ML model deployment procedure on various platforms
4) Apply the concept model deployment using TinyML</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>Introduction to AI/ML Model Deployment</td><td colspan="3">Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>10 session</td></tr>
<tr><td colspan="9">Topics:
Difference between training and deployment, Need of AI/ML model deployment, Types of deployment, System requirements for AI/ML model deployment, Computing memory requirements of AI/ML models, roofline plot, Operational intensity, Speeding up the model deployment, Need of GPU and TPU. Difference between AI hardware and regular hardware, Benefits of using AI hardware</td></tr>
<tr><td>Module 2</td><td>Hardware Platforms for Deployment</td><td colspan="3">Assignment / Quiz</td><td colspan="2">Programming task</td><td>12 session</td></tr>
<tr><td colspan="9">Topics:
Embedded hardware considerations, Various embedded platforms for model deployment, Edge devices, Software and Hardware acceleration, HW/SW Co-design, Pruning, DNN Accelerators</td></tr>
<tr><td>Module 3</td><td>Model Deployment Lifecycle</td><td colspan="3">Assignment</td><td colspan="2">Memory Recall based Quizzes</td><td>12 session</td></tr>
<tr><td colspan="9">Topics:
Model deployment lifecycle, Collect phase, organize phase, deploy phase and monitor phase (technical and customer perspective), Model architecture and model design, model</td></tr>
</table>

compression, Practical constraints in model deployment, Environmental and ethical issues in model deployment process

Module 4	**TinyML**	Assignment	Programming task	**09 session**

Topics:
Introduction to TinyML, Benefits of using TinyML, TinyML challenges, Building and Training a model using TinyML, Deploying model to microcontrollers using TinyML, Tensor Flow Lite, Optimizing latency, energy usage, model and binary size, Privacy, security and Deployment

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Data analytics, Computer Vision - Image & Video Processing, Speech Recognition, Automatic machine translation, object detection etc.

Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Implementation of various concepts in from deep learning using Python/ MATLAB/ SCILAB

Text Book(s):

28. Dianlei Xu, et. al. Edge Intelligence: Architectures, Challenges, and Applications, 1st Edition

29. Pete Warden, Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly, 1st Edition

30. Gregory Keys; David Whiting, Machine Learning at Scale with H2O: A practical guide to building and deploying machine learning models on enterprise systems, Packt Publishing

Reference(s):
Reference Book(s):

36. James Loy "Explore neural networks with Python", Packt Publisher,1st Edition
37. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 1st Edition
38. Seth Weidman "Deep Learning from Scratch ", O'Reilly Media, 1st Edition
39. Francois Chollet "Deep Learning with Python", Manning Publications, 2nd Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

43. https://www.youtube.com/playlist?list=PL0mFAhrXqy9CuopJhAB8GVu_Oy7J0ery6
44. https://sites.google.com/g.harvard.edu/tinyml/home
45. https://tinyml.seas.harvard.edu/courses/
46. https://tinyml.seas.upenn.edu/#resources

47. https://presiuniv.knimbus.com/user#/home

E-content:

48. Manar Abu Talib, Sohaib Majzoub, Qassim Nasir, (May 2020). A systematic literature review on hardware implementation of artificial intelligence algorithms, The Journal of Supercomputing volume 77, pages1897–1938, https://link.springer.com/article/10.1007/s11227-020-03325-8
49. K Arunaggiri Pandian; T S Sai Kumar; Sagar P. Dhandare; S Thabasum Aara, (2021), Development and Deployment of a Machine Learning Model for Automatic Heart Failure Prediction, 2021 Asian Conference on Innovation in Technology (ASIANCON), https://ieeexplore.ieee.org/document/9544787
50. Rajalakshmi Krishnamurthi; Raghav Maheshwari; Rishabh Gulati, (2019), Deploying Deep Learning Models via IOT Deployment Tools, 2019 Twelfth International Conference on Contemporary Computing (IC3), https://ieeexplore.ieee.org/document/8844946
51. Anargyros Gkogkidis; Vasileios Tsoukas; Stefanos Papafotikas; Eleni Boumpa; Athanasios Kakarount, (2022), A TinyML-based system for gas leakage detection, 2022 11th International Conference on Modern Circuits and Systems Technologies (MOCAST) https://ieeexplore.ieee.org/document/9837510

Catalogue prepared by	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code: ECE3152</td><td colspan="3">Course Title: Network System Design
Type of Course: Discipline Elective- VLSI and Embedded Systems Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">-</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The purpose of this course is to enable the students to understand the theoretical concepts, Network interface card, Packet processing, software and hardware for packet processing, switching fabrics and Network processor design etc.</td></tr>
<tr><td>Course Objective</td><td colspan="8">This course is designed to improve the learner’s EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
1) Describe the basics of Network systems and internet, Network Interface Card
2) Understand the Packet classification and processing
3) Illustrate software and hardware architecture for packet processing
4) Apply the network system design concepts in real life scenarios</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction, Network Interface card</td><td>Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">10 session</td></tr>
<tr><td colspan="9">Topics:
Network systems and Internet, Applications vs Infrastructure, review of protocols and packet formats. Network Interface Card: functionality, optimizations for high speed, onboard address recognition, packet buffering, DMA, operation and data chaining.</td></tr>
<tr><td>Module 2</td><td colspan="2">Packet processing</td><td>Assignment / Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">11 session</td></tr>
<tr><td colspan="9">Topics:
Packet Processing: Algorithms - Bridge, lookup and hashing, IP- Fragmentation, Reassembly and forwarding algorithms, TCP – connection recognition and Splicing algorithms; Data structures, functions –error detection and correction, packet classification, queueing and packet discard, scheduling and timing.</td></tr>
<tr><td>Module 3</td><td colspan="2">Software and Hardware architecture for protocol processing</td><td>Assignment</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">12 session</td></tr>
<tr><td colspan="9">Topics:</td></tr>
</table>

Protocol Software on a conventional Processor: Fast packet processing, software interrupts and priorities, software for layered protocols. Hardware Architecture for Protocol Processing: Network system architecture, data rate, packet rate and software router feasibility, overcoming single CPU bottleneck, fine and course-grain parallelism, special purpose/AISC coprocessors, NICs with onboard processing and Data pipeline. Classification and Forwarding: Classification - Packet, software implementation and
Optimization, hardware implementation and optimization, hybrid hardware/software classification. Forwarding – flow forwarding connection and connectionless network; Second generation network systems, embedded processors in second generation systems, classification and forwarding chips.

Module 4	**Switching Fabrics and Network Processors Design**	Assignment	Memory Recall based Quizzes	**12 session**

Topics:
Switching Fabrics: Concepts, synchronous and asynchronous fabrics, taxonomy, crossbar architectures, queueing, sharing data paths, shared bus, medium, memory architectures, multistage fabrics, Banyan architectures – scalability, commercial technologies. Network Processors (NP) Design: 3G network systems, scalability with parallelism and pipelining, costs and benefits of NP, functionality, Ingress and Egress processing, parallel and distributed architecture, The architectural role of NPs, NP design and software emulation.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Onboard address recognition, Data chaining, Connection less network, Switching fabrics, Network processors design etc.

Professionally Used Software: SolarWinds Network Topology Mapper, CADE, Dia Diagram Editor, Microsoft Visio, Network Notepad etc.

Project Work/Assignment:

1. Article review: At the end of the course an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding about the assigned article in an appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment: - Implementation of various concepts in from Network System using Microsoft Visio and Network Notepad.

Text Book(s):

31. Douglas E Comer, Network System Design using Network Processors: Intel 2XXX Version, Prentice Hall Publisher, First Edition, 2005.

Reference(s):
Reference Book(s):

40. Ran Giladi, Network Processors: Architecture, Programming, and Implementation

(System on Silicon), Morgan Kaufmann Publishers, First Edition, 2008.

41. Gregory J Pottie and William J Kaiser, Principles of Embedded Networked Systems Design, Cambridge University Press, First Edition, 2009.

Online Resources (e-books, notes, ppts, video lectures etc.):

48. Online ppts:-https://www.slideshare.net/SubhamKumarYadav2/network-interface-card-243648412
49. Online notes :- https://npbook.cs.purdue.edu/ixp1200/lnotes/490N.pdf
50. https://www.docslides.com/tatyana-admore/fine-grain-parallelismOnline
51. https://www.cisco.com/c/en/us/solutions/enterprise-networks/what-is-a-network-fabric.html

E-content:

52. Chong CY, Kumar SP. Sensor networks: evolution, opportunities, and challenges. Proceedings of the IEEE. 2003 Aug 11;91(8):1247-56.

    https://ieeexplore.ieee.org/abstract/document/1219475

53. Wang Z, Yang F, Ho DW, Liu X. Robust $ H_ {\infty} $ control for networked systems with random packet losses. IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics). 2007 Jul 9;37(4):916-24.

    https://ieeexplore.ieee.org/abstract/document/4267884

54. W. -C. Fang and S. Kedar, "System Architecting and System-on-Chip Design of Intelligent Sensor Networks for Active Volcanoes," 2008 2nd Annual IEEE Systems Conference, Montreal, QC, Canada, 2008,pp.1-8,doi: 10.1109/SYSTEMS.2008.4519025. https://ieeexplore.ieee.org/document/4519025
55. W. Jiang, R. Xu, S. Ma, Q. Wang, X. Hou and H. Lu, "A Memory Saving Mechanism Based on Data Transferring for Pipeline Parallelism," 2021 IEEE Intl Conf on Parallel & Distributed Processing with Applications, Big Data & Cloud Computing, Sustainable Computing & Communications, Social Computing & Networking (ISPA/BDCloud/SocialCom/SustainCom), New York City, NY, USA, 2021, pp.1230-1235,doi:10.1109/ISPA-BDCloud-SocialCom-SustainCom52081.2021.00169.

    https://ieeexplore.ieee.org/document/9644790

Topics related to development of "FOUNDATION": Perceptron, Activation Function
Topics related to development of "EMPLOYABILITY": CNN, LeNet, AlexNet, GoogleNet, ResNet, Highway Networks, PolyNet, YOLO, VGG, Inception, BLSTM, Deep Belief Networks
Topics related to development of "ENTREPRENEURSHIP": Applications of Deep Learning
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY":
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Ethical considerations while developing Deep Learning Models.

Catalogue prepared by	Dr. Manikandan T
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code: ECE3041</td><td colspan="3">Course Title: REAL TIME SYSTEMS
Type of Course Discipline Elective- VLSI and Embedded Systems Basket</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">Microcontroller Applications, Proficiency with ANSI-C and C++ is required. Familiarity with Microcontroller-Based systems along with relevant open source tools.</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The course provides insights into theory, algorithms, protocol concepts, mechanisms and implementation of real-time computer systems. The course deals with the design and applications of all real time aspects of various system components, like OS, memory, communication and an introduction to reliability evaluation methods. The course emphasizes on the basic concepts of real-time programming and also lays a foundation for development of small projects addressing the critical aspects of a modern software development life cycle.</td></tr>
<tr><td>Course objective</td><td colspan="8">The objective of the course is to familiarize the learners with the concepts of Real Time Systems and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
(1) Describe Real time systems.
(2) Understand the concepts of computer control, operating system and computer hardware
(3) Discuss the components of Operating Systems.
(4)Apply suitable methodologies to design and develop Real-Time Systems.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Real-Time Systems</td><td>Assignment/Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">06 classes</td></tr>
<tr><td colspan="9">Topics:
Elements of a Computer Control System, RTS- Definition, Classification of Real-time Systems, Issues in Real Time Computing, Examples of real-time applications, Time Constraints, Classification of Programs. Concepts of Computer Control: Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control</td></tr>
<tr><td>Module 2</td><td colspan="2">Languages for Real-Time Applications</td><td>Assignment / Quiz</td><td colspan="2">Programming task</td><td colspan="2">10 classes</td></tr>
<tr><td colspan="9">Topics:
General Purpose Computer, Single Chip Microcomputers and Microcontrollers, Specialized Processors, Process-Related Interfaces, Data Transfer Techniques, Standard Interface. Syntax Layout and Readability, Declaration and Initialization of Variables and Constants, Compilation of Modular Programs, Data types, Control Structures, Co-routines, Interrupts and Device Handling, Real-time Support, Overview of Real-Time Languages.</td></tr>
<tr><td>Module 3</td><td colspan="2">Operating Systems Concepts</td><td>Assignment/Quiz</td><td colspan="2">System Design Task and Analysis</td><td colspan="2">10 classes</td></tr>
<tr><td colspan="9">Topics:</td></tr>
</table>

Operating systems and hardware support for real-time applications. Posix real-time extensions; features of well-known real-time operating systems;,Real-Time Multi-Tasking OS, Scheduling Strategies, Task Management, Scheduler and Real-Time Clock Interrupt Handler, Task Co-Operation and Communication

Module 4	**RTS Development Methodologies & Intertask Communication**	Assignment/Quiz	System Design Task and Analysis	**10 classes**

Topics:
Foreground/Background System. Yourdon Methodology, Ward and Mellor Method, Hately and Pirbhai Method, Buffering data – Time relative Buffering- Ring Buffers – Mailboxes – Queues – Critical regions – Semaphores – other Synchronization mechanisms – deadlock – priority inversion – process stack management – run time ring buffer .

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
The students will be able to find a career in various domains such as Embedded systems, Smart Home automation and security, Power Generation and Robotics, Automotives.
Professionally Used Software: CODE COMPOSER STUDIO, MATLAB

Text Book(s):

1. Stuart Bennet, "Real-Time Computer Control", 2nd Edn. Pearson Education.
2. "Real time Systems" by I.A.Dhotre Technical publications,1st Edition

Reference(s)

1:C.M. Krishna, Kang G. Shin, "Real -Time Systems", McGraw -Hill International Editions.
2: Phillip. A. Laplante, "Real-Time Systems Design and Analysis", second edition, PHI.
3: Raj Kamal, "Embedded Systems", Tata McGraw Hill, India, third edition

Online and Web resource (s):

1. **NPTEL: https://onlinecourses.nptel.ac.in/noc21_cs98/preview**
2. **Udemy: https://www.udemy.com/course/real-time-systems**
3. **https://www.notesforgeeks.in/2021/08/ec8791-embedded-and-real-time-systems-syllabus-2017-regulation.html**
4. **https://nielit.gov.in/chennai/sites/default/files/Chennai/ED500-Syllabus.pdf**
5. **https://www.rejinpaul.com/2021/06/ec8791-embedded-and-real-time-systems.html**
6. **https://www.cse.iitb.ac.in/~krithi/courses/684/ts-Sep-2004.pdf**
7. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

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E-Content:

1. Control and Communication Challenges in Networked Real-Time Systems by J. Baillieul and P. J. Antsaklis, "Control and Communication Challenges in Networked Real-Time Systems," in *Proceedings of the IEEE*, vol. 95,no.1,pp. 9-28, Jan. 2007, doi:10.1109/JPROC.2006.887290 https://ieeexplore.ieee.org/document/4118454

2. Controller Area Network (CAN) schedulability analysis: Refuted, revisited and revisedDavis, R.I., Burns, A., Bril, R.J. al. Controller Area Network (CAN) schedulability analysis: Refuted, revisited and revised. Real-timeSyst 35,239–272(2007).https://doi.org/10.1007/s11241-007-9012-7 https://link.springer.com/article/10.1007/s11241-007-9012-7

3. Weakly hard real-time systems G. Bernat, A. Burns and A. Liamosi, "Weakly hard real-time systems," in IEEE Transactions on Computers, vol. 50, no. 4, pp. 308-321, April 2001, doi: 10.1109/12.919277

https://ieeexplore.ieee.org/document/919277

4. Scheduling real-time applications in an open environmen Deng and J. W. . -S. Liu, "Scheduling real-time applications in an open environment," Proceedings Real-Time Systems Symposium, 1997, pp. 308-319, doi: 10.1109/REAL.1997.641292. https://ieeexplore.ieee.org/document/641292

5. Design and Operation of ETA, an Automated Ellipsometer P. S. Hauge and F. H. Dill, "Design and Operation of ETA, an Automated Ellipsometer," in *IBM Journal of Research and Development*, vol. 17,no.6,pp.472-489,Nov.1973,doi:10.1147/rd.176.0472. **https://ieeexplore.ieee.org/document/5391322**

Topics relevant to "EMPLOYABILITY SKILLS": Data Transfer Techniques, Compilation of Modular Programs, Operating systems and hardware support for real-time applications, Priority Structures and Task Management - **for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.**

Catalogue prepared by	**Mrs.ANNAPURNA.H.S**
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3042	**Course Title: MEMS and Nanotechnology** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Analog Electronics					
Anti-requisites	**NIL**					
Course Description	The course deals with Micro electro mechanical systems (MEMS), devices and technologies. The course also discusses Micro-machining and microfabrication techniques, including planar thin- film processing, silicon etching, wafer bonding, photolithography, deposition and etching. The course also includes Transduction mechanisms and modelling in different energy domains. The course emphasizes on analysis of micromachined capacitive, piezoresistive and thermal sensors/actuators and applications.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of MEMS and Nanotechnology and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: v) Discuss Methods for Processing MEMS materials vi) Develop Characteristic techniques of micro system fabrication process vii) Demonstrate the concepts of Nano technology viii) Illustrate nano materials and various nano measurements techniques ix) Implement nano scale manufacturing					
Course Content:						
Module 1	Introduction and Fundamentals MEMS Device Physics	Assignment	Quizzes	**12 Sessions**		
Topics: Historical background development of microelectronics, evolution of micro sensors, MEMS, emergence of micro machines. Micro sensors: Introduction, thermal sensors, mechanical sensors, flow sensors and Introduction to SAW DEVICES.Microfabrication of MEMS: Surface Micromachining, Bulk Micromachining, And LIGA Process: Introduction, Basic Process and Application, micromachining of polymeric MEMS devices.Actuation: Electrostatic Actuation, Piezoelectric Actuation, Thermal Actuation, Magnetic Actuation, Mechanical Vibrations, The single degree of Freedom System, The many Degrees of freedom system						
Module 2	MEMS Materials and fabrication process Modelling	Assignment	Quizzes	**8 Sessions**		
Topics: Metals, semiconductors, thin films for MEMS and their deposition techniques, materials for polymer MEMS. Microstereolithography: Introduction, Scanning Method, Projection Method, Applications. Solid modeling: Numerical Simulation of MEMS, Mechanical Simulation, Electrostatic Simulation.						
Module 3	MEMS Switches and RF Applications	Assignment	Quizzes	**12 Sessions**		
Topics: Switch parameters, basics of switching, Switches for RF and microwave applications,						

actuation mechanisms for MEMS devices, dynamics of switch operation, MEMS switch design considerations, Microwave Considerations, Material Consideration, Mechanical Considerations modeling and evaluation.
MEMS based RF and Microwave circuits : RF Filters, Micromachined Phase shifters, and Micromachined antenna.

Module 4	MEMS Inductors and Capacitors	Assignment	**8 Sessions**

Topics:
MEMS Inductors: self and mutual inductance, micromachined inductors, modelling and design issues of planar inductors, variable inductor and polymer based inductor. MEMS Capacitors: MEMS gap tuning capacitor, MEMS area tuning capacitor, Dielectric Tunable capacitors.

Targeted Application & Tools that can be used:
Applications in various fields such as biomedical, optical, wireless networks, aerospace, and consumer products.

Text Book(s):

T1: Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," McGraw-Hill, 1st edition, ISBN: 0072393912.

T2: RF MEMS: Theory, Design, and Technology, Gabriel M. Rebeiz, John Wiley & Sons, 2003.

Reference(s):
Reference Book(s):

R1 RF MEMS & Their Applications by Vijay K. Varadan, K. J. Vinoy and K. A. Jose John Wiley & Sons, 2003

R2 Introduction to Microelectromechanical Microwave Systems (2nd Edition) by Hector J.De Los Santos, Artech house.

R3 Mems Mechanical Sensors Microelectromechanical system series Srephen Beeby/Artech House

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Video lectures on "MEMS and Microsystems" by Prof. Santiram Kal, IIT Kharagpur _ https://nptel.ac.in/courses/117/105/117105082/
2. Video lectures on "Micro and Smart systems" by Prof. Sudip Misra", IISc Bangalore. https://nptel.ac.in/courses/112/108/112108092/
3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

e-learning materials –

1. Liao, Meiyong. "Progress in semiconductor diamond photodetectors and MEMS sensors." *Functional Diamond* 1, no. 1 (2022): 29-46.
2. Xu, Rui-Jia, and Yu-Sheng Lin. "Actively MEMS-based tunable metamaterials for advanced and emerging applications." *Electronics* 11, no. 2 (2022): 243.
3. Liu, Hua-Feng, Zhi-Cai Luo, Zhong-Kun Hu, Shan-Qing Yang, Liang-Cheng Tu, Ze-Bing Zhou, and Michael Kraft. "A review of high-performance MEMS sensors for resource exploration and geophysical applications." *Petroleum Science* (2022).
4. Zhang, Shenghai, Shaohua Luo, Shaobo He, and Hassen M. Ouakad. "Analog circuit implementation and adaptive neural backstepping control of a network of four Duffing-type MEMS resonators with mechanical and electrostatic coupling." *Chaos, Solitons & Fractals* 162 (2022): 112534.

Topics relevant to "EMPLOYABILITY SKILLS": Micro sensing for MEMS, Numerical Simulation of MEMS, MEMS switch design considerations, MEMS Inductors and MEMS Capacitors - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3045**	**Course Title: Sensor Technology** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	[1] Measurements and Instrumentation,[2] Linear Integrated Circuits Basic concepts of physical principles applied in measurement and a comprehensive understanding, on how measurement systems are designed, calibrated, characterized, and analyzed. Basics of sources and detectors of various Optical sensing mechanisms and provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration.						
Anti-requisites	NIL						
Course Description	The purpose of this course is Used to converting a physical parameter into an electrical quantity, Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Sensor Technology and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: (1) Design and develop sensors using optical methods with desired properties (2) Evaluate performance characteristics of different types of sensors. (3) Realize different type of sensors used in real life applications and paraphrase their importance. (4) Create analytical design and development solutions for sensors.						
Course Content:							
Module 1	Sensor fundamentals and characteristics and Physical Principles of Sensing	Assignment	Error Analysis	**12 Sessions**			
Topics: Sensors, Signals, and Systems, Sensor Classification, Sensor Characteristics-Transfer Function, Mathematical Model, Functional Approximations, Polynomial Approximations, Sensitivity, Linear Piecewise Approximation, Multidimensional Transfer Functions, Calibration, Calibration Error Electric Charges, Fields, and Potentials, Capacitance, Magnetism, Induction, Resistance, Piezoelectric Effect, Pyroelectric Effect, Hall Effect, Thermoelectric Effects, Temperature and							

Thermal Properties of Materials, Light, Dynamic Models of Sensor Elements.				
Module 2	Pressure, force, displacement and weight measurement, Flow measurement, RF sensing	Assignment	Analyzing Physical properties	**10 Sessions**
Topics: Capacitive and inductive transducers, Displacement Sensor (LVDT), Strain Sensors – strain gauges, its principle, applications, types of strain gauges, Load cells, Piezo-electric sensors, Motion sensors. Basic principle of flow meter, Differential pressure flow meters, Variable area flow meter, Volumetric flow meter, Hotwire anemometer, Magnetic and ultrasonic flow meter, Rota meter, Hall effect transducer working and measurement techniques Basic principle of EM fields, Antenna, RFID, Near Field and Far Field Sensing, Radar and Navigation, EMI & EMC sensing.				
Module 3	Optical Components of Sensors and Temperature Sensors	Assignment/Quiz	Optical communication	**10 Sessions**
Topics: Introduction, Radiometry, Photometry, Windows, Mirrors, Fiber Optics and Waveguides, Concentrators, Coatings for Thermal Absorption, Nano-optics. Resistance Vs Temperature characteristics for different materials, Thermistors, Thermocouples - thermoelectric effects for thermocouples, thermocouple tables, RTD, Other Thermal Sensors.				
Module 4	Interface Electronic Circuits	Mini project	Interfacing with the components	**10 Sessions**
Topics: Input Characteristics of Interface Circuits, Amplifiers, Light-to-Voltage Converters, Excitation Circuits, Analog-to-Digital Converters, Direct Digitization, Capacitance-to-Voltage Converters, Batteries for Low-Power Sensors.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Application Area is real time applications like Automotive, Manufacturing, Aviation, Marine, Medical, Telecom, Chemical, and Computer Hardware. Professionally Used Software: keil/Arduino.cc				
Project work/Assignment:				
1. **Article review:** At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 2. **Presentation:** There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. **Project Assignment:** Design a weighing machine having a range of 0-3 Kg with a sensitivity of 3 mg. What modification he/she has to do to change the upper range to 100 Kg with a sensitivity of 100 mg. **Assignment 1:** Develop a displacement measurement system with the following sensors: i.e Inductive transducer (LVDT) **Assignment 2:** Develop a sensor system for force measurement using piezoelectric transducer				
Text Book(s): 1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York. 2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.				
References 1. Gerd Keiser,"Optical Fiber Communications", 2012, 4th edition, McGraw-Hill Science, Delhi. 2. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition,				

CRC Press, Florida.
3. Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey.
4. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York.

Digital References

1. **NPTEL - https://nptel.ac.in/courses/108/108/108108147/**
2. **Coursera - https://www.coursera.org/lecture/intelligent-machining/sensors-2w3Am**
3. **Udemy - https://www.udemy.com/course/automotive-sensor-and-actuator-technology/**
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content:

1. Huang, Sunan, Jikuang Yang, and Fredrik Eklund. "Evaluation of remote pedestrian sensor system based on the analysis of car-pedestrian accident scenarios." *Safety Science* 46, no. 9 (2008): 1345-1355. https://doi.org/10.1016/j.ssci.2007.08.004
2. Obradovic, Dragan, Henning Lenz, and Markus Schupfner. "Fusion of sensor data in Siemens car navigation system." *IEEE Transactions on Vehicular Technology* 56, no. 1 (2007): 43-50. https://ieeexplore.ieee.org/abstract/document/4067135
3. Trung, Nguyen Thanh, and Philipp Häfliger. "A submicrowatt implantable capacitive sensor system for biomedical applications." *IEEE Transactions on Circuits and Systems II: Express Briefs* 62, no. 2 (2014): 209-213. https://ieeexplore.ieee.org/abstract/document/6949636
4. Fedtschenko, Tatjana, Alexander Utz, Alexander Stanitzki, Andreas Hennig, Andre Lüdecke, Norbert Haas, and Rainer Kokozinski. "A new configurable wireless sensor system for biomedical applications with ISO 18000-3 interface in 0.35 µm CMOS." *Sensors* 19, no. 19 (2019): 4110. https://www.mdpi.com/1424-8220/19/19/4110

Topics relevant to "EMPLOYABILITY SKILLS": Calibration Dynamic Models of Sensor Elements, Fiber Optics and Waveguides, Batteries for Low-Power Sensors - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3046	**Course Title: Low Power VLSI Design Type of Course Discipline Elective- VLSI and Embedded Systems Basket**		**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of digital circuits like gates, flip-flops, registers, multiplexers, decoders. Fundamentals of Analog and Digital VLSI design					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the fundamentals of low power VLSI architectures and systems. The course insights into the various methods used to confront the low power issue VLSI system from circuit level to system level of abstraction. This course enhances student's abilities to develop a low power design architecture and analysis of various parameters.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Low Power VLSI Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the sources of power dissipation in CMOS integrated circuits. 2. Illustrate different approaches of Low power design at circuit level. 3. Summarize issues in Low Power Design at circuit and logic levels. 4. Explain leakage sources and reduction techniques.					
Course Content:						
Module 1	**Device & Technology Impact on Low Power**	Assignment/Quiz	Designing and Analysis task	**10 Sessions**		
Topics: **Introduction:** Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. **Device & Technology Impact on Low Power:** Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.						
Module 2	**Power analysis**	Assignment/Quiz	Simulation and analysis task	**10 Sessions**		
Topics: **Simulation Power analysis**: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.						
Module 3	**Low Power Design at circuit and logic level**	Assignment/Quiz	Design Analysis	**10 Sessions**		
Topics: **Low Power Design Circuit Level**: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. **Logic level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.						
Module 4	**Leakage Power minimization Approaches, Adiabatic switching,**	Assignment/Project	Data Analysis	**10 Sessions**		

	Memory Design			

Topics: **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components.

Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network.

Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Application Area is high-performance digital systems, such as microprocessors, digital signal processors (DSPs).
Software: Xilinx-ISE; VIVADO; Cadence-Virtuoso.
Open source tools: EDA Playground; LT-Spice; Microwind.

Textbook(s):

1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI circuit design", John Wiley & Sons Inc., 2000. 1st Edition

References:

Reference Book(s):

1. G.K.Yeap, Farid N.Najm, "Low Power VLSI design and technology", World Scientific Publishing, 1996. (1st Edition)
2. Soudris, Dimitrios, Christrian Pignet, Goutis, Costas, "Designing CMOS circuits for low power," Springer International, 2004. (1st Edition)
3. Ajit Pal, —Low-Power VLSI Circuits and Systems‖, Springer, 2015. (1st Edition)
4. A. P. Chandrakasan, R.W. Broderson, "Low Power Digital VLSI Design", IEEE Press, 1998. (1st Edition)
5. Gary K.Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 1998. (1st Edition)
6. Jan M. Rabaey, Massoud Pedram, "Low power Design methodologies", Kluwer Academic Press, 1996. (1st Edition)
7. Michael Keating, David Flynn "Low Power Methodology Manual for System-On-Chip Design" Springer Publication 2007. (1st Edition)

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Lecture videos for Low Power VLSI Circuits & Systems by Prof. Ajit Pal, IIT Kharagpur – NPTEL https://nptel.ac.in/courses/106/105/106105034/
2. PPT on Low Power VLSI Design, Link : https://nijwmwary.com/low-power-vlsi-circuits-systems/
3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Shanbhag, Naresh R. "Algorithms transformation techniques for low-power wireless VLSI systems design." *International Journal of Wireless Information Networks* 5, no. 2 (1998): 147-171. **https://link.springer.com/article/10.1023/A:1018869519651**
2. H. O. Elwan and A. M. Soliman, "Low-voltage low-power CMOS current conveyors," in IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications, vol. 44, no. 9, pp. 828-835, Sept. 1997, doi: 10.1109/81.622987.
3. C. Park, Y. A. Tavares, J. Lee, J. Wo and M. Lee, "5th-Order Continuous-Time Low-Pass Filter Achieving 56 MHz Bandwidth 30.5 dBm IIP3 With a Novel Low-Distortion Amplifier," in IEEE Transactions on Circuits and Systems II: Express Briefs, vol. 68, no. 6, pp. 1768-1772, June 2021, doi: 10.1109/TCSII.2020.3039247.
4. Carvajal, R., Torralba, A., Tombs, J. *et al.* Low Voltage Class AB Output Stage for

CMOS Op-Amps Using Multiple Input Floating Gate Transistors. *Analog Integrated Circuits and Signal Processing, springer,* **36,** 245–249 (2003). https://doi.org/10.1023/A:1024774506261	
Topics relevant to "EMPLOYABILITY SKILLS": Probability & frequency, probabilistic power analysis techniques - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3047	**Course Title: CAD for VLSI** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of CAD for VLSI and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 13. Describe various graph algorithms. 14. Define computational complexity of different physical design algorithms. 15. Employ various algorithms for Partitioning, Placement and Floor planning. 16. Illustrate different types of routing algorithms.					
Course Content:						
Module 1	**Design methodologies and CAD tools**	Quiz	Memory Recall based Quizzes		**10 classes**	
Topics: Design domains, design actions, design methods and technologies, VLSI Design automation tools, data structure for graph representation, Graph algorithms: depth first search, breadth first search, Dijkstra's algorithm and prim's algorithm**.**						
Module 2	**Computational complexity and layout compaction**	Assignment	Design Analysis		**9 classes**	
Topics: Combinatorial optimization problems, decision problems, Complexity classes, NP completeness and NP hardness, symbolic layout, applications of compaction, informal problem formulation, maximum distance constraints, and algorithms for constraint graph compaction**.** A Longest-path Algorithm for DAGs, the Liao Wong Algorithm and the Bellman-Ford Algorithm.						
Module 3	**Placement, Partitioning and Floorplanning**	Assignment	Design Analysis		**9 classes**	
Topics: Wire length estimation, Types of placement problem, placement algorithms-constructive placement, iterative improvement, KL partitioning algorithm, floor planning concepts-terminology, representation and problems, shape functions and floor plan sizing.						
Module 4	**Routing and Logic**	Assignment	Programming and simulation		**9 classes**	

	Synthesis			

Topics:

Area routing, channel routing-models, vertical and horizontal constraint graphs, left edge algorithm, channel routing algorithms, introduction to combinational logic synthesis, Binary decision diagrams: ROBDD principles, implementation, construction and manipulation and two level logic synthesis. . Variable Ordering, Applications to Verification and Applications to Combinatorial Optimization. Testing: Fault Models, Simulation, Basic test generation.

Targeted Application & Tools that can be used:
Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.
Professionally Used Software: VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project work/Assignment:

Project Assignment:

13. Develop a heuristic algorithm for finding a maximum bipartite subgraph in circle graphs.
14. Suggest modifications to the Kernighan-Lin algorithm to speed up the algorithm.
15. Design an efficient heuristic algorithm based on maze routing to simultaneously route two 2-terminal nets on a grid graph. Compare the routing produced by this algorithm with that produced by Lee's maze router by routing one net at a time.
16. Implement the approximation algorithm for finding a *k*-independent set in circle graphs. Experimentally evaluate the performance of the algorithm by implementing an exponential time complexity algorithm for finding a *k*-independent set.

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

7. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.
8. M. L. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI circuits", Kluwer, 2001.

Reference(s):

10. Stephen Trimberger, "Introduction to CAD for VLSI", Kluwer Academic publisher, 2002.
11. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, 2nd edition.
12. G. Hachtel and F. Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer, 1998. 3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers; 3rd ed., 1999.

Online and Web resource (s):

19. https://nptel.ac.in/courses/106/106/106106088/
20. https://cse.ucsd.edu/faculty-research/vlsicad-computer-aided-design
21. http://www.facweb.iitkgp.ac.in/~isg/CAD/
22. https://www.youtube.com/watch?v=hJTK5nj1iq8
23. https://www.youtube.com/watch?v=WLdbujc-aH4
24. https://www.youtube.com/watch?v=zkFRfmySFOw

E-Content:

13. H. Martin Bucker and Christian Sohr Bucker "Reformulating a Breadth-First Search Algorithm on an Undirected Graph in the Language of Linear Algebra" in IEEE 2014 International Conference on Mathematics and Computers in Sciences and in Industry,

33–35. doi:10.1109/MCSI.2014.40
https://ieeexplore.ieee.org/abstract/document/7046157

14. Farnaz Towhidi, Arash Habibi Lashkari "Binary Decision Diagram (BDD)" in IEEE 2009 International conference on future computer and communication, 03-05 April 2009, doi:10.1109/ICFCC.2009.31 https://ieeexplore.ieee.org/abstract/document/5189833.

15. Archana K Rajan, Deepika Bhaiya "VLSI partitioning using parallel kernighan lin algorithm" in IEEE 2017 International Conference on Communication and Signal Processing (ICCSP)-CHENNAI, India (2017.4.6-2017.4.8)doi:10.1109/ICCSP.2017.8286727 https://ieeexplore.ieee.org/abstract/document/8286727.

16. Groeneveld R "Physical design challenges for billion transistor chips" in IEEE International Conference on Computer Design-Freiberg, Germany(16-18 Sept. 2002), 78–83. doi:10.1109/ICCD.2002.1106751. https://ieeexplore.ieee.org/abstract/document/1106751.

Topics relevant to "EMPLOYABILITY SKILLS": Graph algorithms, algorithms for constraint graph compaction floor planning concept, Binary decision diagrams - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout**.**

Catalogue prepared by	Ms. R Anusha
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3048**	**Course Title: FPGA Design for Embedded Systems** **Type of Course: Discipline Elective-VLSI and Embedded Systems Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Digital logic and Digital design					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the basics of FPGA. This course aims to build knowledge on understanding programmable architectures and configuring them for different applications. The course also help student learn about the Verilog programming structures and modelling types which can be used for digital system design and help in building of an over-all concept for an application which can be tested on FPGA interfaced with various other hardware's.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using FPGA Board					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the basic concepts of FPGA. 2. Apply embedded system concepts with appropriate FPGA based on applications 3. Write Verilog code for combinational and sequential logics CO4: Students can design a communication module using Verilog. 4. Design a motor control module using Verilog					
Course Content:						
Module 1	**FPGA Architecture And Overview**	Quiz	Memory Recall based Quizzes			**9 Sessions**
Topics: Embedded system design flow - Robot Control System - Digital Design Platforms - Microprocessor based Design - Single-chip Computer/Microcontroller-based Design - Application Specific Standard Products (ASSPs) - Design Using FPGA - robotic rover application - FPGA Devices - FPGA and CPLD – Architecture of a SPARTAN-3ETM FPGA - Floor Plan and Routing - Timing Model for a FPGA - FPGA Power Usage.						
Module 2	**Embedded System Design**	Assignment	Theoretical Understanding			**10 Sessions**
Topics: FPGA-based Embedded Processor - Design Re-use Using On-chip Bus Interface - Creating a Customized Microcontroller - Robot Axis Position Control - FPGA-based Signal Interfacing and Conditioning – Motor Control Using FPGA- Case Studies for Motor Control -Prototype Using FPGA- FPGA Design Test Methodology						
Module 3	**Verilog Constructs**	Assignment	Theoretical Understanding			**10 Sessions**
Topics: VLSI Design flow- behavioral style, the dataflow style, and structural style - Data types - Constants - Assignment Statement - Operators - Conditional Expressions - Statement types - Vector operations – Bit selects - Functions - Gate level modeling.						
Module 4	**Verilog Modeling Building FPGA projects**	Assignment	Programming assignment			**13 Sessions**

Topics:
Design and test a Binary Coded Decimal Adder, Design and test a PWM Circuit, with verification by simulation. Design and test an ADC circuit, using Quartus Prime built-in tools to verify your circuit design. Enhance and test a working design, using most aspects of the Quartus Prime Design Flow and the NIOS II Software Build Tools (SBT) for Eclipse.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Application Area – Video imaging, Automotive computing, Aerospace applications.
Signal processing, Medical devices
Professionally Used Software: PyCharm,Qt Creator,MATLAB,Eclipse,WebStorm

Project work/Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

2.Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment- Implement various digital circuits in Verilog and verify the same on FPGA board., Write a report on the research article given., Explore the robotic application of embedded system with a research article and verify the coding done in the same.

Text Book

1. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays" Springer-Verlag London Limited, 2009
2. John F. Wakerly, Digital Design Principles and Practices", Pearson Education, Asia, III Edition, 2003.

References

1. Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press, 2011.
2. J. Bhasker, "A Verilog HDL Primer, Third Edition Hardcover", Star Galaxy Publishing; 3rd edition, 2005.
3. J.Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing; 3rd edition, 1998.

Online Resources (e-books, notes, ppts, video lectures etc):

1.NPTEL - https://onlinecourses.nptel.ac.in/noc22_cs46/preview
2.Udemy - https://www.udemy.com/course/fpga-embedded-design-verilog/
3.Coursera - https://www.coursera.org/learn/intro-fpga-design-embedded-systems
4.Online Notes -https://ieeexplore.ieee.org/document/6186912
5.Online Notes - https://ieeexplore.ieee.org/document/6472742

E-content :

1. Carlos Leopoldo Carreón-Díaz De León ;Sergio Vergara-Limón; ,"Parameter Identification of a Robot Arm Manipulator Based on a Convolutional Neural Network" , IEEE Access (Volume: 10) 2022 , https://ieeexplore.ieee.org/document/9780143
2. Swapna Chintakunta, Raghavendra Rao Kanchi, Ramanjappa Thogata, "Designing an introductory FPGA – Based embedded system laboratory" ,American Journal of Embedded Systems and Applications ,2022 https://www.researchgate.net/publication/297717116_Designing_an_Introductory_FPGA-Based_Embedded_System_Laboratory
3. Wendell F.S. Diniz Vincent Fremont, "An FPGA-based architecture for embedded systems performance acceleration applied to Optimum-Path Forest classifier" ,Microprocessor and Microsystems, 2017 , https://reader.elsevier.com/reader/sd/pii/S0141933116302290?token=EAEE66D704C273

BA8004F8BFD5C95E49BB56FF0D4ACB324649EE1124C866FFB6B952BEC1BF49CD6F6BD5E180F07F18CF&originRegion=eu-west-1&originCreation=20220719080055	
Topics Relevant to development of "FOUNDATION SKILLS": VLSI Design flow- behavioral style, the dataflow style, and structural style Topics Relevant to development of "EMPLOYABILITY": Design Using FPGA - robotic rover application - FPGA Devices - FPGA and CPLD	
Catalogue prepared by	Mrs Anupama Sindgi
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3049**	**Course Title: Developing Secure Embedded Systems** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L- T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic understanding of Microprocessor 8085, Microcontroller 8051. Basic knowledge of VLSI, Assembly language programming and c programming.					
Anti-requisites	NIL					
Course Description	The course focuses on design, implementation and explore hardware and software security measures design using appropriate techniques and tools and to develop an ability to understand comprehensively the technologies and techniques underlying in building an embedded solution in a trustful and secure environment.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING methodologies of secure embedded systems.					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Explain the origin and characteristics of Embedded Systems. (2) Apply various techniques to secure an Embedded Systems. (3) Demonstrate various security vulnerabilities and its solutions (4) Employ various techniques to deploy and secure Embedded systems.					
Course Content:						
Module 1	**Embedded System Primer**	Quiz	Memory Recall based Quizzes			**10 Classes**
Topics: Embedded system processor- PIC, ARM- Programming input and output, Components for embedded system, Models of program, Assembly, linking, loading, Compilation techniques, Program optimization.						
Module 2	**Layers of embedded system**	Assignment / Quiz	Simulation Based			**10 Classes**
Topics: Embedded Design life cycle, Embedded System modelling, Layers of an Embedded System – hardware layer – Application layer – Software Layer – middleware. EDLC Approaches, Interfaces to the external world. FPGA- The Role of FPGAs, FPGAs types, FPGAs vs Custom VLSI, Fine - Grained and Course - Grained Reconfigurable Architecture, Case Studies.						

Module 3	**Introduction to security and tools**	Assignment	Simulation Based	**12 Classes**

Topics: Security properties (confidentiality, integrity and availability), security vulnerabilities, threats and attacks, security models, policies and mechanisms, Encryption Techniques, Basic notions of security protocol.

Block Ciphers - DES, AES, Blowfish, modes of operation, Stream Ciphers-RC4, Linear and Differential cryptanalysis

Module 4	**Security in Embedded Systems**	Assignment	Design Based	**08 Classes**

Topics: Cryptography, Trusted computing, FPGA Flexibility, Trusted -untrusted zone isolation, Physical attack protection, Access control mechanism, Incentive based Trust model deployment for securing Embedded system and prevention of DDoS.

Project work/Assignment:

Project Assignment: 1. A systematic review of future trends in security and trust models in IoT.
2. Secure WEB-Deployment using Embedded Systems
3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.
4. Students will be made into group and given the programming assignment at the end of each module. Students need to use Embedded Development Kits for these assignments.
Tools:

1. **Kiel C5**
2. **Raspberry Pi**

Textbook(s):

1. **Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition, Press, 2016.**

2. **Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016.**

Reference Books:

3. Shibu, K. V. Introduction to embedded systems, 1st edition, Tata McGraw-Hill Education, 2009. Vahid, Frank, and Tony D. Givargis. Embedded system design: a unified hardware/software introduction, 1 st edition, John Wiley & Sons, 2006.
4. Zhu Y. Embedded Systems with ARM® Cortex-M3 Microcontrollers in Assembly Language and C. E-Man Press; 2014.
5. Wolf W. FPGA-based system design. Pearson education; 2004 Jun 15.

E-content:

6. SEnSE – An Architecture for a Safe and Secure Integration of Safety-Critical Embedded Systems **https://ieeexplore.ieee.org/document/8555740**
7. Design and Implementation of Secure Embedded Systems Based on Trustzone **https://ieeexplore.ieee.org/document/4595549**
8. High-Security System Primitive for Embedded Systems **https://ieeexplore.ieee.org/document/5368926**
9. Design and implementation of embedded secure web server for ARM platform **https://ieeexplore.ieee.org/document/6022952**

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Free online self-paced course :- https://bcourses.berkeley.edu. 2. Online notes :- https://mitpress.mit.edu/books/internet-things 3. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html 4. Online ppts :- https://www.upf.edu/pra/en/3376/22580 5. Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt 6. https://www.udemy.com/course/embedded-electronics-bootcamp-from-bit-to-deep-learning/ 7. https://nptel.ac.in/courses/106105159 8. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home
Topics relevant to development of "EMPLOYABILITY": Security and Trust implementation in Embedded Systems. **Topics related to development of "SKILL":** Leading skills for Embedded system design, networking and security.

Catalogue prepared by	Nipun Sharma
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3052**	**Course Title:** **Introduction to Embedded Machine Learning** **Type of Course Discipline Elective- VLSI and Embedded Systems Basket**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Comprehension of concepts/logics in Machine and Deep Learning Algorithms. Basics of Embedded Systems. Basics of Python programming for Machine and Deep Learning Algorithms.					
Anti-requisites	NIL					
Course Description	This course aims at provide introduction of an emerging field embedded machine learning. This course gives best possible insight of deploying machine learning applications on embedded systems using TinyML.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Introduction to Embedded Machine Learning and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: (i) Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. (ii) Demonstrate the importance of VHDL in real time applications. (iii) Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. (iv) Analyze the developed artificial intelligence based VHDL code for power, area and delay using the FPGA device					
Course Content:						
Module 1	**Overview of Machine Learning Algorithms**	Quiz	Memory Recall based Quizzes			**14 session**
Supervised Learning, Regression- Linear Regression, Ridge Regression, LASSO, and Classifications of Supervised Learning: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, Perceptron, Logistic Regression, Unsupervised Learning- K-means Clustering, and PCA.						
Module 2	**Overview of Embedded Devices for Machine Learning Algorithms**	Assignment / Quiz	Programming and Simulation task			**12 session**
RISC and CISC Architectures, Introduction to ARM® Architecture and ARM® Cortex™-M TM4C123X processor, Comparing ARM® Cortex™-M TM4C123X processor with TM4C129X architecture, FPGA.						
Module 3	**TinyML**	Assignment	Programming			**19 session**
Fundamentals of TinyML, Need of TinyML, Advantages, Deploying TinyML, Factors to be considered while deploying TinyM.						
Targeted Application & Tools that can be used: **JOBS-** • Execute a lead role for the design, development, and verification of real-time machine learning algorithms for innovative power tools. • A state-of-the-art field that brings the performative power of ML to shrink deep						

structured earning networks to fit on tiny hardware.

- Implement machine learning algorithms in embedded environments.
- Manage the development of data collection methods, test plans/procedures and test cases for training, evaluation, and verification of machine learning algorithms.

TOOLS-

Python (NumPy, Pandas, sklearn, xgboost, TensorFlow, keras, etc.) MySQL, Snowflake, GCP/AWS and Tableau Java.

Text Book(s):

32. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.

33. Pete Warden, Daniel Situnayake, "*TinyML*", 1st Edition, O'Reilly Media, Inc.

Reference Book(s):

52. Mano, M. Morris and Ciletti Michael D., "*Digital Design*", 5th Edition, Pearson Education, 2020.

53. Oliver Theobald , "*Machine Learning For Absolute Beginners: A Plain English Introduction*", 2nd Edition, The author, 2017.

54. Bert Moons, Daniel Bankman, Marian Verhelst, Embedded Deep Learning Algorithms, Architectures and Circuits for Always-on Neural Network Processing", First Edition, Springer Link .

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Harward University Course on **"TinyML"** https://pll.harvard.edu/course/fundamentals-tinyml?delta=0
2. NPTEL Course on **"An Introduction to Artificial Intelligence"** by Prof. Mausam, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs56/preview
3. NPTEL Course on **"Deep Learning"** by Prof. Sudarshan Iyengar & Prof.Mitesh M. Khapra , IIT Madras, https://onlinecourses.nptel.ac.in/noc19_cs85/preview
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Ahmad Shawahna , Sadiq M. Sait , and Aiman El-Maleh, "FPGA-Based Accelerators of Deep Learning Networks for Learning and Classification: A Review", IEEE Access, Volume 7, 2019, pp:7823-7859. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8594633
2. Mohammed Elnawawy , Assim Sagahyroon , and Tamer Shanableh, "FPGA-Based Network Traffic Classification Using Machine Learning", IEEE Access, Volume 8, 2020, pp: 175637-175650. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9205799
3. Tarek Belabed, Maria Gracielly F. Coutinho , Marcelo A. C. Fernandes , Carlos Valderrama Sakuyama , and Chokri Souani, "User Driven FPGA-Based Design Automated Framework of Deep Neural Networks for Low-Power Low-Cost Edge Computing", IEEE Access, Volume 9, 2021, pp: 89162 – 89180. https://ieeexplore.ieee.org/document/9458248

Shuai Li, Yukui Luo, Kuangyuan Sun, Nandakishor Yadav, and Kyuwon Ken Choi, "A Novel FPGA Accelerator Design for Real-Time and Ultra-Low Power Deep Convolutional Neural Networks Compared With Titan X GPU", IEEE Access, Volume 8, 2020, pp: 105455 – 105471. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9108269

Catalogue prepared by	Ms.Natya.S

Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3090	**Course Title: Digital System Design using VERILOG** **Type of Course: Discipline Elective, General Basket**		**L- T-P- C**	**3**	**0**	**3**
Version No.	2.0				
Course Pre-requisites	Low Power VLSI Design, Foundations for VLSI Design				
Anti-requisites	NIL				
Course Description	The purpose of this course is to enable the students to understand the fundamentals of Digital and embedded systems. The course insights into the various methodology and models for real-world circuits and enhances student's abilities to implement programmable logic devices for specific chip design. The course emphasizes on memory types with error detection and correction techniques and also demonstrates the use of Hardware Description Language (HDL) to develop designs for high level synthesis and simulation.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Artificial Neural Networks and attain SKILL DEVELOPMENT through PROBLEM SOLVING techniques				
Course Outcomes	On successful completion of the course students shall be able to: **1)** Construct the combinational circuits, using discrete gates and programmable logic devices. **2)** Describe how arithmetic operations can be performed for each kind of code, and also combinational circuits that implement arithmetic operations. **3)** Design a semiconductor memory for specific chip design. **4)** Design embedded systems using small microcontrollers, larger CPUs/ DSPs, or hard or soft processor cores.				
Course Content:					
Module 1	**Introduction and Methodology**	Quiz	Memory Recall based Quiz	**12 Session**	
Topics: Digital Systems and Embedded Systems, Real-World Circuits, Models, Design Methodology; **Combinational Basics:** Combinational Components and Circuits, Verification of Combinational Circuits; **Number Basics:** Unsigned integers, Signed Integers, Fixed point Numbers, Floating point Numbers; **Sequential Basics:** Sequential Data paths and Control Clocked Synchronous Timing Methodology.					
Module 2	**Memories**	Assignment	Design and Simulation Based	**08 Session**	
Topics: Concepts of memory, Memory Types, Error Detection and Correction.					
Module 3	**Implementation Fabrics**	Project	Simulation and small hardware based	**12 Sessio**	

				n
Topics: Integrated Circuits, Programmable Logic Devices, Packaging and Circuit boards, Interconnection and Signal integrity.				
Module 4	**Design Methodology**	Project	Software design based	**08 Session**
Topics: Design flow, Design optimization, Design for test, Nontechnical Issues				

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Professionally Used Software: Xilinx-VIVADO or modelsim/MATLAB

X`Targeted Application:

1. Fuzzy Based PID Controller Devices using VHDL in Transportation.
2. Design and Implementation of a Real-time Traffic Light Control
3. Design and VLSI implementation of anti-collision robot processor using RFID technology
4. Various sensor and Biomedical Health Monitoring gadget implementation.

Project work/Assignment/Quiz:

1. Students will be made into group and given the programming assignment at the end of each module. Students need to use VERILOG for these assignments.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format Presidency University Library Link .
3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.

Text Book(s):

T1 Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010

T2 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.

Reference(s):

Reference Book(s):

1. Ming-Bo Lin, ''Digital System Designs and Practices: Using Verilog HDL and FPGAs", Wiley, 2008
2. Charles Roth, Lizy K. John, Byeong Kil Lee, "Digital Systems Design Using Verilog", Cengage, 1st Edition.
3. Donald E. Thomas, Philip R Moorby, 'TheVerilog Hardware Description Language", Springer, Fifth edition.
4. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition.
5. Donald E. Thomas, Philip R Moorby, 'The Verilog Hardware Description Language", Springer Science+Business Media, LLC, Fifth edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Introduction to Hardware Modeling using verilog by IIT KHARAGPUR - Bing video
2. Introduction to VERILOG LANGUAGE FEATURES PART 1 by IIT KHARAGPUR - Bing video
3. System Design Through VERILOG - Course (nptel.ac.in)
4. VERILOG MODELING OF THE PROCESSOR PART 1 using Verilog by IIT KHARAGPUR - YouTube
5. Hardware Design Representation by IIT KHARAGPUR - YouTube
6. Introduction to DATAPATH AND CONTROLLER DESIGN PART 1 by IIT KHARAGPUR - YouTube

E-content: (Presidency University E-resources)

1. Verilog HDL based FPGA design | IEEE Conference Publication | IEEE Xplore
2. Towards Optimised FPGA Realisation of Microprogrammed Control Unit Based FIR Filters | IntechOpen
3. Improvisation of Gabor Filter design using Verilog HDL | IEEE Conference Publication | IEEE Xplore
4. Behavioral modeling and simulation of analog/mixed-signal systems using Verilog-AMS | IEEE Conference Publication | IEEE Xplore
5. Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language | IEEE Conference Publication | IEEE Xplore
6. https://presiuniv.knimbus.com/openFullText.html?DP=http://182.72.188.196/LocalGuru/

Topics relevant to "EMPLOYABILITY SKILLS": Programmable Logic Devices, Packaging and Circuit boards, Interconnection and Signal integrity for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Ms. Maitraiyee Konar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3092	**Course Title: Photonic Integrated Circuits Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	A background in silicon photonics, fiber optics, or semiconductors is recommended, but not required. Proficiency in linear algebra and calculus will enhance understanding of design concepts. The course emphasizes on How to model photonic devices, working, analysis and design of photonic devices and also to create compact models for them . Additionally, this course will create a foundation for future courses such as advanced photonics.					
Anti-requisites	NIL					
Course Description	Photonic integrated circuits has evolved into a key technology with transformative impact on a wide variety of applications, ranging from high-speed data transmission to further quantum optics and optical computing.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of the student by using PARTICIPATIVE LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1: Apply advanced techniques and tools of sensing and computation to solve multi-disciplinary challenges in industry and society. 2: Strong cognizance in the area of high-speed data transmission. 3: To learn how to develop photonic devices. 4: Evaluate the gap between theoretical basics and high-impact applications by combining a lecture with a hands-on design.					
Course Content:						
Module 1	Introduction and review	Quiz	Quizzes	**8 sessions**		
Topics: Optical communications: short-reach, long-haul, and data centers communications. Economic drivers towards photonic integration. Interaction of optical waves with dielectric and metal interfaces. Boundary conditions, total internal reflection. Review of silicon PN-and PN-junctions. Junction diode static and transient characteristics.						
Module 2	Fundamentals of Silicon photonics	Assignment	Theory	**7 sessions**		
Topics: Symmetric dielectric waveguides. Asymmetric dielectric waveguides. Rectangular waveguides. Computational methods for integrated photonics, design and fabrication of silicon waveguide structures. Waveguide loss, scattering, absorption, radiation.						
Module 3	Photonic systems	Assignment	Quizzes	**7 sessions**		
Introduction to photonic systems for short-reach and long-haul optical communications. Modulation formats, receiver and transmitter characteristics, optical link budget, BER and penalties. Introduction to data center optical networks. Optical switching. Optical switches.						
Module 4	Photonic Crystal Structures	Assignment	Assignments	**8 sessions**		

Introduction to physics of 1D period structures Photonic crystal waveguides and bends Photonic crystal integrated circuits Waveguide couplers Add/Drop filters,Mach-Zehnders Delay lines.

Targeted Application & Tools that can be used:

Tools: N.A

Project work/Assignment:

1.Design a project based on analysis, design and testing of the silicon photonic circuits.

Text Book(s):

3. S.L.Chuang, Physics of Photonic Devices, second edition, Wiley, New York, 2009.
4. B. Saleh and M.C. Teich, Fundamentals of Photonics, 2nd ed., Wiley, 2007.

References

4. G.P Agrawal, Fiber Optic Communication Systems, Wiley, ISBN 0470505117
5. R.G feller and U. Bapst. Wireless in-house communication via diffuse infrared radiation, SPIE Press
6. S. Hranilovic. Spectrally Efficient Signalling for Wireless Optical Intensity Channels. PhD thesis, Dept. of Elec. & Comp. Engineering, University of Toronto, 2003.

Online Resources & E-content(e-books, notes, ppts, video lectures etc.):

Digital Content :

1. **NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview**
2. **EDX - https://www.edx.org/course/silicon-photonics-design-fabrication-and-data**
3. **COURSERA - https://www.coursera.org/specializations/optical-engineering.**

E – Leraning materials:

4. **https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6833068&isnumber=6832912**
5. **https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6990118&isnumber=6988061**
6. **Presidency University Library Link** https://presiuniv.knimbus.com/user#/home

Research Papers

1. 1P. Qiao, G. Su, Y. Rao, C. J. Chang-Hasnain and S. L. Chuang, "Modeling of long-wavelength high contrast grating VCSELs and comparison with experiment," *CLEO: 2013*, 2013, pp. 1-2.
2. Guan-Lin Su, Pengfei Qiao, C. -Y. Lu, D. Bimberg and S. L. Chuang, "Low-threshold dielectric-cavity microlasers," *2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications*, 2014, pp. 1-2.
3. Weik, M.H. (2000). integrated fiber optic communications system. In: Computer Science and Communications Dictionary. Springer.**https://doi.org/10.1007/1-4020-0613-6_9232**
4. Weik, M.H. (2000). fiber optic communications system. In: Computer Science and Communications Dictionary. Springer. **https://doi.org/10.1007/1-4020-0613-6_9221**

Topics Relevant to development of "Foundation skills": Non linear Optics
Topics Relevant to development of "Employability": Development of Silicon photonics

Catalogue prepared by	Dr Balaji ka
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Data Transfer Technologies Basket

Course Code: ECE3053	**Course Title: Data Communication and Networking** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**	**L- T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Problem Solving using JAVA (CSE1001), Digital Communication –ECE3007 Basic programming skills for implementing protocols. Basic concepts of baseband and band pass transmission through AWGN channel, digital modulation modulators and Detectors, baseband and bandpass modulation schemes.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the student to the basics of computer communications. Data communications and networking includes long haul network hardware, circuit and packet switching, interfaces between computer and network hardware, and performance issues. The course develops technical as well as debugging skills. The course enables the students to build various networks among different distributed networks.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Summarize the layers of OSI model, TCP/IP model associated with data communication 2) Discuss different noise handling and MAC protocols at data link layer. 3) Employ internet and transport protocols in various applications. 4) Illustrate Application layer protocols and Security functions.					
Course Content:						
Module 1	Network Models & Physical Layer		Quizzes	**7 Session**		
Topics: Introduction-Data Communications, Networks, internet, Protocols and Standards, layered tasks, The OSI Model layers, TCP/IP Protocol Suite, Network Models, Circuit switched networks						
Module 2	Data Link Layer	Assignment	Design oriented	**14 Session**		
Topics: Framing, Flow and Error control, Protocols for Noiseless and noisy channels-Simplest Protocol, Stop and wait protocol, Stop and wait automatic repeat request, Go-Back-N automatic repeat request, HDLC, Random access, ALOHA, CSMA, Controlled access, channelization, wired LAN, Wireless LAN. FDMA, CDMA, TDMA						
Module 3	Network and Transport Layer	Assignment	Design Analysis	**9 Session**		
Topics: IPv4 Addresses - spaces, notation, classful and classless addressing; IPv6 Addresses - structure, address space, internet protocols - Headers, IPv4, IPv6, Transport protocols-UDP-user datagram, check sum, operation and uses, TCP-services, features, segment, TCP connection.						

Module 4	Application layer and Security	Assignment	Application based analysis	**10 Session**

Topics: Domain name system-Name space, Domain name space, DNS in Internet, resolver, Overview of Cryptography and IP Security.

List of Laboratory Tasks: NIL

Targeted Application & Tools that can be used:

Application Area are, companies like CISCO, IBM, TCS, Infosys, where network routing and maintenance of computer networks are handled.

Professionally Used Software:

Network simulator tools like NS2, NS3, GNS3, Cisco Packet Tracer, Putty, Microsoft Visio, Secure CRT.

Project work/Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**

2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Assignment: (a) Create a simple network model with multiple scenarios, collect statistics on network performance through the use of simulation tools, analyse statistics and draw conclusions on network performance. (b) Performance analysis of layer 1 and layer 2 (physical and data link layer) devices in LAN.

Text Book(s):

1. Behrouz A Forouzan, "Data Communications and Networking", 5th Edition, Tata McGraw-Hill, 2012.

Reference(s):

Reference Book(s):

1. James F. Kurose, Keith W. Ross, "Computer Networks", 2nd Edition, Pearson education 2003.
2. Wayne Tomasi, "Introduction to Data communication and Networking", Pearson education, 2007.
3. W. Stallings, "Data and Computer Communications", 8th edition, Pearson Prentice Hall, 2013.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://www.cs.vu.nl/~ast/CN5/
2. https://open.lib.umn.edu/exploringbusiness/chapter/15-5-data-communications-networks/
3. https://www.ibm.com/in-en/cloud/learn/networking-a-complete-guide
4. https://www.youtube.com/watch?v=mYWsllbszYQ
5. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=129584&printable=1
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Agrawal D. and Zeng, Q. Introduction to Wireless and Mobile Systems. Pacific Grove, CA, NJ: Brooks/Cole Thomson Learning, 2003.
2. Couch, L. Digital and Analog Communication Systems. Upper Saddle River, NJ: Prentice Hall, 2000.
3. Gast, M. 802.11 Wireless Network. Sebastopol, CA: O'Reilly, 2000. Garcia, A. and Widjaja, I, Communication Networks. New York, NY: McGraw-Hill, 2003.
4. Halsall, F. Multimedia Communication. Reading, MA: Addison-Wesley, 2001. Hamming, R. Coding and Information Theory. Upper Saddle River, NJ: Prentice Hall,

1980.	
Topics related to development of "FOUNDATION": Layered Computer Network Models. Topics related to development of "EMPLOYABILITY": IPv4 and TCP protocols. Topics related to development of "ENTREPRENEURSHIP": Computer Networks and Domain names.	
Catalogue prepared by	Dr Rakesh Chowdhury
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: ECE3054	**Course Title: MOBILE COMMUNICATION** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**1) Analog Communication** **2) Digital Communication**					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to appreciate the need for fundamentals of wireless cellular / mobile / personal communications systems and basics of designing simple communication systems. Following this, various propagation effects and propagation mode will be analyzed to improve the received signal quality in mobile communication. Various application of mobile communications and its protocols is discussed. The Course provides various multiple access techniques and Standards in Cellular mobile Communication. These concepts will enable the students to carry out their research and development activities, placement opportunities and foundation to design the cellular architecture.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Describe the infrastructure to build the mobile communication system. 2) Summarize the characteristics of different multiple access techniques in mobile communication 3) Discuss the basics of GSM and GPRS. 4) Illustrate the concept of Mobile IP and mobile ad-hoc network.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Mobile Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Content:						
Module 1	**INTRODUCTION TO MOBILE COMMUNICATION**	Quiz	Quizzes	**10 Classes**		
Topics: Basics of communication system, Wired and wireless network, Cellular Concepts- cell structure, frequency reuse, cell splitting, channel assignment, capacity power control, Interference, handoff, interference, signal propagation-reflection, refraction, diffraction, path loss of radio signal, multipath propagation, spread spectrum						
Module 2	**MEDIUM ACCESS CONTROL**	Assignment	System Representation task	**09 Classes**		
Topics: MAC- hidden and exposed terminals, near far terminal, FDM,SDM, TDM,CDM, Multiple Access Scheme –SDMA – FDMA – TDMA – CDMA – Cellular Wireless Networks, Aloha-classical, slotted, comparison of SDMA/TDMA/FDMA/CDMA						
Module 3	**GSM and GPRS (2G and 2.5G)**	Project	Small hardware based	**10 Classes**		
Topics: Evolution of 1g/2g/2.5g/3g, GSM- services and features, architecture, traffic channel, control channel, localization and calling, GPRS – features, architecture						
Module 4	**MOBILE NETWORK LAYER**	Quiz	Memory Recall based Quizzes	**10 Classes**		

Mobile IP – Entities and Terminology, IP Packet Delivery, Agent Discovery, Registration, Tunneling and Encapsulation. Mobile Adhoc-Network -Routing, DSDV ,Dynamic Source Routing

Targeted Application & Tools that can be used:

Application Area is Communication, connection of devices by BLUETOOTH, Accessing the Internet, Locating and Tracking-GPS, security systems, television remote control, computer-interface devices, Wi-Fi.

Professionally Used Software/Hardware: Embedded C Programing and Arduino integration with GSM Module, SMS gateway simulator which can be used for testing purpose.

Text Book(s)

1) Jochen Schiller, "*Mobile Communications*", Pearson Education, second edition, 2008.

2) Wireless Communications: Principles and Practice (2nd Edition) , Theodore S. RappaportTheodore S. Rappaport.

Online Resources(e-books, notes, ppts, video lectures etc.):

1. https://youtu.be/f2wlHL1Sok8?list=PLuv3GM6-gsE3ypUYh43pPuZsXxJVG1e7F.
2. https://www.javatpoint.com/mobile-communication
3. https://www.vssut.ac.in/lecture_notes/lecture1428730613.pdf
4. https://kanchiuniv.ac.in/coursematerials/ECE_COURSE_MATERIAL_ODD%20SEMESTER/ECE_COURSE%20MATERIAL_ODD%20SEMESTER/Dr.M.A.ARCHANA_Mobile%20Communication%20Networks.pdf
5. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

(IV) E-content :

1. Jack L. Burbank "Second-Generation (2G) Cellular Communications" in Wireless Networking: Understanding Internetworking Challenges , IEEE, 2013, pp.250-365, doi: 10.1002/9781118590775.ch6. https://ieeexplore.ieee.org/document/6581606
2. Lukić, M. Koprivica, N. Nešković and A. Nešković, "Experimental performance analysis of the 2G/3G/4G public mobile network," 2016 24th Telecommunications Forum (TELFOR), 2016, pp. 1-4, doi: 10.1109/TELFOR.2016.7818767. https://ieeexplore.ieee.org/document/7818767
3. T. Mshvidobadze, "Evolution mobile wireless communication and LTE networks," *2012 6th International Conference on Application of Information and Communication Technologies (AICT)*, 2012, pp. 1-7, doi: 10.1109/ICAICT.2012.6398495. https://ieeexplore.ieee.org/document/6398495

Mobile Communications, IEEE Network March, April 1994, vol.: 8 Issue: 2, **DOI:** 10.1109/65.272935,https://ieeexplore.ieee.org/document/272935

Reference(s)

1. William Stallings, "*Wireless Communications and Networks*", Pearson Education, second edition, 2002

2. C.K.Toh, "*AdHoc Mobile Wireless Networks*", Pearson Education **,** first edition, 2003.

Topics relevant to "SKILL DEVELOPMENT": Signal propagation, Multiple Access Scheme, Medium Access Control - for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Dharmesh Srivatsav
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: ECE3055	**Course Title: Satellite Communication** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	**[1] Analog Communication,2] Digital Communication, 3] Antenna and wave propagation** **Basic concepts of Digital modulation, antenna and wave propagation, SNR and CNR.**						
Anti-requisites	**NIL**						
Course Description	The course introduces the students to the basic concept in the field of satellite communication. This will enable the students to know how to place a satellite in an orbit and about the earth & space segment. The satellite services like broadcasting are also studied thoroughly.The course also provides the student with the thorough understanding of the fundamental principles when designing global satellite systems for communication purpose, unique challenges of designing, developing, fielding, maintaining, and operating satellite communications systems payload.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Satellite Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: **1)** Explain the fundamentals of Satellite Communication **2)** Apply the concept of Satellite Communication Link Budget. **3)** Illustrate the different parts of Satellite including On Board & Earth Segment. **4)** Discuss the applications of satellite mobile communication & various satellite systems adopted						
Course Content:							
Module 1	**Introduction to Satellite systems**	Quiz	Memory Recall based	**10 Sessions**			
Topics: Introduction History, The Indian Scenario, INTELSAT, Frequency Allocation,List of present satellites with their features, Basic Satellite System, Satellite Orbit, Geostationary Orbit, Orbital Parameter & Perturbations,Launching Procedures - launch vehicles and propulsion							
Module 2	**Orbits & Link Budget Calculation:**	Case Study	Simulation/Signal Analysis task	**10 Sessions**			
Topics: Introduction: Keplar's Laws, Space Link:, EIRP, Transmission losses, Link Power Budget, System Noise, CNR, Uplink, Downlink, Effects of Rain, Combined CNR							
Module 3	**Space Segment**	Assignment	Simulation/Signal Analysis task	**10 Sessions**			
Topics: Introduction: Power Supply Unit, Attitude Control, Station Keeping, Thermal Control, TT &C, Transponders, Antenna Subsystem							
Module 4	**Satellite**	Assignment	Modeling Task, System Representation task	**12 Sessions**			

	Communication Services			

Satellite Access, SPADE System, Spread Spectrum Transmission & Application, GPS & its application, .INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

Targeted Application & Tools that can be used:

Application Areas in Weather forecasting ,Radio and TV broadcast satellites, Military satellites. Navigation, Global telephone backbones, Connections for remote or developing areas, Global mobile communication.

Professionally Used Software: Matlab and Satellite Communication Simulators.

Project work/Assignment/Quiz:

Case Study:

Identify the position of the HD Dish antenna placed over the building roof, analyse the orientation part of the dish antenna, its operating frequency bands and the Video signal processing through the setup box. Also justify why the downlink frequency should be lower than the uplink frequency bands.

Assignment1:

In most satellite TV receivers, the first IF band is converted to a second, fixed IF. Why is this second frequency conversion required?

Assignment2:

A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12hours. Given that the eccentricity is 0.002, calculate the semimajor axis. The earth's equatorial radius is 6378.1414 Km.

Text Book:

Dennis Roddy, Satellite Communication, 2006, 4th Edition ,McGraw Hill Publication.

Online Resources (e-books, notes, ppts, video lectures etc.):

- https://nptel.ac.in/courses/117101055/
- Online notes :- https://mitpress.mit.edu/books/satellite communication
- Free online self-paced course :- https://bcourses.berkeley.edu.
- https://www.cl.cam.ac.uk/teaching/0809/satellite communication/InfoTheoryLectures.pdf
- https://www.slideshare.net/nitmittal/satellite -comm-trans-ece
- https://www.accessengineeringlibrary.com › content › book
- https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9210567
- Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content

- Technology trends and challenges of antennas for satellite communication systems Y Rahmat-Samii, AC Densmore - IEEE Transactions on 2014 https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6945379
- Broadband LEO satellite communications: Architectures and key technologies Y Su, Y Liu, Y Zhou, J Yuan, H Cao… - … Communications, 2019 https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8700141
- Development and future applications of satellite communications E Lutz, H Bischl, H Ernst, F David, M Holzbock Awa https://link.springer.com/chapter/10.1007/0-387-23072-6_15
  A new broadband magic tee design for Ka-band satellite communications VS Kumar, DG Kurup - IEEE Microwave and Wireless …,019 https://ieeexplore.ieee.org/abstract/document/8602357

References

1. T. Pratt, C. Bostian, J. Allnutt, Satellite Communication, Wiley Publication

2. W. L. Pitchand, H. L. Suyderhou, and R. A. Nelson, "*Satellite Communication Systems Engineering*," Pearson Education

Topics related to "EMPLOYBILITY": Design of spade systems, space link budget estimation

and design of pico satellite for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Dr.M.S Divya Rani Mrs. Annapurna
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3056	**Course Title: Wireless Communication and Networks** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**	**L- T-P- C**	**3**	**0**	**0**	**3**
Version No.	**2.0**					
Course Pre-requisites	Analog Communication, Digital Communication, Wireless Networks, Basic concepts c communication system, modulation, demodulation, well acquainted with terms suc as evolution of wireless standards-1G to 4G and PAN technologies.					
Anti-requisites	NIL					
Course Description	The objective of this course is build an understandings of the core issues encountere in the design of wireless networks. The course includes the fundamentals of wireles communication and provides an overview of existing and emerging wireles communication networks. It covers fundamentals of cellular communications, multipl access technologies and various wireless networks including past and futur generation networks. Further, the students will understand the basic concept c wireless system design and get familiar with various wireless networks. They will ge the idea from the fundamentals of wireless communication and the evolution c wireless networks from first generation to LTE and LTE advanced after completion c this course.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by usin PROBLEM SOLVING techniques using open source Design Tools.					
Course Outcomes	On successful completion of the course students shall be able to: 1. Apply cellular concepts for reducing interference in mobile communication 2. Distinguish various multiple access techniques along with area of its application 3. Classify the various existing WLAN and WPAN network topologies 4. Summarize wireless communication standards based on architecture and operatio					
Course Content:						
Module 1	**An Introduction to Wireless Communication and Cellular Concept**	Quiz	Memory Recall based Quiz		**10 Session**	

Topics:
Communication Systems, Types of Wireless Communication Systems, Classification of modern wireles systems. Limitations of wireless networks. **:** Introduction to cell structure, Hexagonal cell geometry concept of frequency reuse.

Module 2	**Capacity Enhancement and Multiple Access Techniques**	Assignment	Case Study Based	**12 Sessio**

Topics:
Channel assignment strategies, Capacity enhancement techniques, Interference and system capacity Handoff, Trunking and grade of service. Introduction to multiple access, Frequency division multipl access, Time division multiple access, Code division multiple access and Spread spectrum multipl access.

Module 3	**Multiple Antenna Techniques**	Project	Small hardware based	**08 Sessio**

Topics:
MIMO systems, spatial multiplexing, System model, Pre-coding, Beam forming, transmitter diversity receiver diversity, Channel state information-capacity in fading and non-fading channels.

Module 4	**Wireless Networks**	Project	Small hardware based	**09 Sessio**

Topics:
Introduction to wireless Networks, Advantages and disadvantages of Wireless Networks, OSI mode WLAN topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison o IEEE 802.11 a,b, and g standards, WPAN technologies.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Professionally Used Software: Arduino, Matlab integration with GSM receiver, integrate the GSM devic with any microcontroller, the embedded programming, SMS gateway simulator which can be used fo testing purpose.

Targeted Application:
Communication, connection of devices by BLUETOOTH, Television and Radio Broadcasting, Radi Frequency Identification (RFID), Mobile Telephone System (Cellular Communication), Radar, Infrare Communication etc.
Accessing the Internet, Locating and Tracking-GPS, security systems, television remote contro computer-interface devices, Wi-Fi, wireless power transfer and many projects based on mobil communications are applications of mobile communication.
Enhance Security: The different types of wireless communication can enhance security. Fo example, walkie-talkies transmit and receive radio signals

Project work/Assignment/Quiz:
Bluetooth based Garage Door Opening, Smart Card Technology-based Security System

Assignment 1: Election Day results are out. Everyone wants to congratulate the winner. Suppose th cell phone for everyone displays "G" on its top right corner of screen. Identify the technology standard Draw its architecture and explain the main blocks.
Assignment 2: Distinguish various multiple access techniques along with area of its application
Assignment 3: Given codes are C_1= [-1,-1,-1,-1], C_2 = [1,-1,-1,1], C_3 = [-1,1,1,1], C_4 = [-1,1,1,-1] Considering these codes, Show that whether CDMA can be applied with these codes. Determine total no of users in this system and give reason for your answer. Comment on capacity of CDMA. Why CDMA i

called as Spread Spectrum Technology?

Book/Article review: At the end of each module a book reference or an article topic will be given to a individual or a group of students. They need to refer the library resources and write a report on the understanding about the assigned article in appropriate format **Presidency University Library Link .**

Text Book(s):

T1 Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010

T2 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.

Reference(s):

Reference Book(s):

R1 Wireless Telecom System and Networks, Mullet: Thomson Learning 2006.

R2 Fundamentals of wireless communication, David Tse, Pramod Viswanath, Cambridge 2005.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK
2. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT
3. https://nptel.ac.in/courses/112/105/112105249/
4. https://www.intechopen.com/chapters/66880
5. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content: (Presidency University E-resources)

1. https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications
2. https://www.intechopen.com/books/5408
3. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w
4. https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/
5. https://www.mdpi.com/books/pdfview/book/1088

Topics related to development of "FOUNDATION": Beyond 5G Architecture
Topics related to development of "EMPLOYABILITY": Capacity enhancement techniques, LTE-architecture, OFDM, MIMO and Cognitive radio.
Topics related to development of "ENTREPRENEURSHIP": OFDM, MIMO and Cognitive radio
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Capacity enhancemer techniques, Interference and system capacity, Handoff, Trunking and grade of service.

Catalogue prepared by	Ms. Maitraiyee Konar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: **ECE3057**	**Course Title: Radar Engineering** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basic concepts of analog modulation anddemodulation schemes and probability theory						
Anti-requisites	**NIL**						
Course Description	This is an advanced research-oriented course designed for undergraduate students. Thiscourse will enablestudents' knowledge towards detection and tracking of radar signals. The course emphasizes on working, analysis and design of Radar wireless communication system. Additionally, this course will create a foundation for future courses such as optical Communication and Free Space Wireless Communication system.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Radar Engineering and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING						
Course Outcomes	On successful completion of this course the students shall be able to: 1: Explain the basic principle of RADAR System. 2: Solve the RADAR Equation and to calculate Transmitter power. 3: Discussthe working principle of CW and Frequency Modulated Radar. 4: Compare the principlesof MTI and Pulse Doppler Radar.						
Course Content:							
Module 1	**Basics of Radar**	Quiz	Memory Recall based Quizzes	**10 Sessions**			
Topics: **Basics of Radar:** Introduction, Maximum Unambiguous Range, Radar Waveforms, Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power. Simple form of the Radar Equation, Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar.							
Module 2	**The Radar Equation**	Assignment / Quiz	Comprehension based Quizzes and assignments	**9 Sessions**			
Topics: **The Radar Equation:** Prediction of Range Performance, Detection of signal in Noise, Minimum Detectable Signal, Receiver Noise, SNR, Modified Radar Range Equation, Probability of Detection, Radar Cross Section of Targets.							
Module 3	**MTI and Pulse Doppler Radar**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB	**10 Sessions**			
Topics: **MTI and Pulse Doppler Radar:** Introduction, Principle, Doppler Frequency Shift, Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler, MTI Radar with – Power Amplifier							
Module 4	**Tracking Radar**	Assignment	Project implementations in software, batch wise presentations	**10 Sessions**			

Topics:
Tracking Radar: Role of the radar tracker,-Plot to track association, Track initiation, Track maintenance, Track smoothing, Types of Tracking Radar Systems- Lobe switching, conical scan, Alpha-beta tracker, Kalman filter, Multiple hypothesis tracker (MHT), Interacting multiple model (IMM)

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Data analytics,Automatic machine translation, object detection etc.

Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox

Project Work/Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link :**https://puniversity.informaticsglobal.com/login**
2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
3. Project Assignment:- Implementation of various concepts in from Radar Engineering using Python/ MATLAB

Text Books:

T1. M.I. Skolnik, Introduction Radar Systems, 2nd Edn,Mc Graw Hill Book Co.,1981
T2. F.E. Terman, Radio Engineering, Mc Graw Hill Book Co, 4th Edn. 1955
T3 .Simon Kingsley And Shaun Quegan, Understanding Radar Systems, Mcgraw Hill Book Co.,

Reference(s):

Reference Book(s):

1. Nathanson, F E, " Radar Design Principles" Scitech Publishing.
2. Hovanessian, S.A., "Radar System Design And Analysis", Artech House
3. D.K.Barton, Modern Radar Systems Analysis, Artech House, 1988.
4. B,Edde, Radar: Principles, Technology, Applications, Prentice Hall, 1993

Online Resources (e-books, notes, ppts, video lectures etc.):

- NPTEL - https://nptel.ac.in/courses/108/105/108105154/
- COURSERA - https://www.coursera.org/specializations/optical-engineering.
- https://doi.org/10.1175/BAMS-88-11-1753.
- https://doi.org/10.1175/1520-0426(1997)014<1502:DADOAP>2.0.CO.
- Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E contents :

1. Zhang, G. F., R. J. Doviak, D. S. Zrnić, R. Palmer, L. Lei, and Y. Al-Rashid, 2011; Polarimetric phased-array radar for weather measurement: A planar or cylindrical configuration. *J. Atmos. Oceanic Technol.* https://www.semanticscholar.org/paper/Polarimetric-Phased-Array-Radar-for-Weather-A-or-Zhang-Doviak/537ca7fc87fd73f07da2f7044f1020d795eef77d
2. Wurman, J., Y. Richardson, C. Alexander, S. Weygandt, and P. F. Zhang, 2007; Dual-Doppler analysis of winds and vorticity budget terms near a tornado. *Mon. Wea. Rev.*https://www.semanticscholar.org/paper/Dual-Doppler-Analysis-of-Winds-and-Vorticity-Budget-Wurman-Richardson/2257f06925d8c069b27726e800307340e1313b93
3. Zhang, Yiming; Zhang, Shuai; Pedersen, Gert Frølund, 2020;A Simple and

<table>
<tr><td colspan="2">Wideband Decoupling Method for Antenna Array Applications. https://vbn.aau.dk/ws/files/320484972/manuscript.pdf
4. Said Mikki, dept. of ECECS, University of New Haven, West Haven, CT, USA,2018;Quantum Antenna Theory for Secure WirelessCommunications. file:///C:/Users/Admin/Downloads/Quantum_Antenna_Theory_EuCap2020_%20(1)%20(1).pdf</td></tr>
<tr><td colspan="2">Topics relevant to “EMPLOYABILITY”: Tracking Radar, Applications of Radar, Power and operating frequency for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.</td></tr>
<tr><td>Catalogue prepared by</td><td>Ashwini B</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 19th BOS held on 06/07/2024</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 24th , Dated 03/08/2024</td></tr>
</table>

Course Code: ECE3058	**Course Title:RF Engineering** **Type of Course: : Discipline Elective- Data Transfer Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	To succeed in this course the student should be comfortable with basic concepts of Analog and Digital Communication courses. Thebasic analog and digital modulationtechniques needed to translatesignal from original frequency to a specified RF frequency. Multiple Access techniques are used to extend the RF communication for accommodating multiple users.					
Anti-requisites	NIL					
Course Description	The course is designed for undergraduate students to introduceRF components and architecture with applications. This course will enable the students to classify different active and passive components with design and noise considerations. Thiswill also enable the students to seek employment opportunities, research and development activitiesindesign of RF control circuit and various systemarchitectures.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of RF Engineering and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of this course the students shall be able to: 1)Discuss the importance of RF design and its applications. 2) Classify active RF devices and noise considerations. 3) Apply the concepts of RF engineering in RF control circuits. 4)Summarize various radio frequency architectures.					
Course Content:						
Module 1	RF system-Basic architecture	Assignment	Programming and simulation Task			**9 Sessions**
Topics: Introduction, Importance of using Radio frequency design, Applications. RF behavior of passive Components-Resistors, Capacitors, Inductors. Transmission line analysis Parallel RLC tank, Series RLC networks, Impedance Matching, Pi match, T match.						
Module 2	Active RF components	Assignment	Programming and Simulation Task			**10 Sessions**
Topics: RF diodes, Bipolar junction transistors, RF Field Effect transistor, Metal Oxide Semiconductor Transistors, High Electron Mobility Transistors, Semiconductor Technology Trends						
Module 3	RF Transistor amplifier and Mixer Design	Project Assignment	Programming Task			**9 Sessions**
Topics: Amplifier power relations, Broadband High power and Multistage Amplifiers. Basic Characteristics of Mixers, Frequency domain considerations, Single ended Mixer design, Single and double balanced mixer, Integrated active mixer, Image reject Mixer						

Module 4	**TRANSCEIVER ARCHITECTURES**	Assignment	Data collection and analysis	**10 Sessions**

Receiver Architectures: Basic Heterodyne Receivers, Modern Heterodyne Receivers, Direct-Conversion Receivers, Transmitter Architectures:Direct-ConversionTransmitter,Modern Direct-Conversion Transmitters, Heterodyne Transmitters, OOK Transceivers

Targeted Application & Tools that can be used:

Applications: Radar Communication, Satellite Communication, Future generation network design

Tools: Matlab/Simulink

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. Project Assignment:Design auser friendly interface for the fast access to control high voltage electrical circuit operations using RF technology.

Textbooks:

1. Behzad Razavi , " RF Microelectronics ", Pearson Education ,6th Edition
2. Reinhold Ludwig,GeneBogadanov ,"RF Circuit design,Theory and Applications", Pearson India, 2011,2nd Edition

Digital Reference(s)

3.ebook:https://www.atnf.csiro.au/people/Tasso.Tzioumis/sms2014/presentations/Clegg(RF_Engineering).ppt

4.ebook:https://www.ti.com/lit/ml/slap127/slap127.pdf

References:

1. Kai Chang ,"RF and Microwave Wireless system", Pearson Education edition, 2015,1st Edition.
2. W. H. Hayt, McGraw "Engineering Electromagnetics"-Hill Book Company,8th Edition.

Online Reference(s)

NPTEL: https://nptel.ac.in/courses/117/102/117102012/#

NPTEL: https://nptel.ac.in/content/syllabus_pdf/117102012.pdf

Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Ajinkya C Bapat1, Sonali U Nimbhorkar, Department of Computer Science and Engineering, G.H. Raisoni College of Engineering, Nagpur, RFID Based Object Tracking System Using Collaborative Security Protocol,DOI 10.4010/2016.943 ISSN 2321 3361 © 2016 IJESC,Researcharticle,Volume 6,Issue no.4 https://ieeexplore.ieee.org/abstract/document/8465897
2. Jasmine JoseDepartment of Electronics and Telecommunication Engineering, Don Bosco Institute of Technology, Mumbai, India, Sherin George; Lydia Bosco; Juliet Bhandari; Freda Fernandes; Ashwini Kotrashetti,A review of RF energy harvesting systems in India,International Conference on Technologies for Sustainable Development (ICTSD),2015

https://ieeexplore.ieee.org/document/7095838

3. John Walker; Daniel Myer; Frederick Raab; Chris Trask,Classic Works in RF Engineering: Combiners, Couplers, Transformers, and Magnetic Materials, Artech https://ieeexplore.ieee.org/document/9100964

Topics relevant to "EMPLOYABILITY": Transceiver Architectures for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Mrs AKSHATHA K
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3059	**Course Title: Security in Computer Networks** **Type of Course: : Discipline Elective- Data Transfer Technologies Basket**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	To succeed in this course the student should be comfortable with the practice of applied statistics involving analysis of data, which can be used to define the network security algorithms. The knowledge in digital communication helps to apply these algorithms in modern communication systems.					
Anti-requisites	NIL					
Course Description	The course is designed for undergraduate level engineering students. The aim of this course is to introduce the students to the areas of cryptography and network security. Variety of basic cryptographic primitives along with advanced algorithms is discussed in the course. This course develops a basic understanding of the major challenges in network security, authentication protocols, IP security and firewalls. These topics will enable the students to select employment opportunities and research and development activities.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Security in Computer Networks and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Identify the major challenges with Network security 2) Describe the classical encryption techniques and the major tasks in network security services. 3) Explain the encryption and decryption of a plain text with DES and AES. 4) Learn the different authentication protocols and basics of IP security.					
Course Content:						
Module 1	Introduction to network security and classical encryption techniques	Assignment	Programming Task	**10 Classes**		
Topics: Introduction: Cryptography, cryptanalysis, attacks, services, securitymechanisms.Classical Encryption Techniques: Symmetric key cryptography Caesar cipher, mono alphabetic cipher, play fair cipher, hill cipher, poly alphabeticcipher, OTP, transposition techniques, rotor machines, steganography						
Module 2	Symmetric ciphers and pseudorandom number generation	Article review	Programming Task	**10 Classes**		
Topics: Block Ciphers: Block Ciphers and the Data Encryption Standard: DES algorithm, differential and linear cryptanalysis, triple DES. Block cipher design principles, block cipher modes of operation, advanced encryption standard: AES, Pseudorandom number generation, prime numbers, Euler's theorem and CRT. Stream Ciphers: RC4. Cryptographic Hash Functions: Applications of hash Functions.MAC and Digital Signatures.						
Module 3	Public key cryptography and network security	Project Assignment	Programming and Simulation Task	**10 Classes**		
Topics: Public Key Cryptography: Principles of public key cryptosystem, RSA algorithm, security of RSA. Diffiehellman key exchange.Network Security: Security attacks, Transport level security, Wireless						

Network Security, Electronic mail security, IP security.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Cyber security, Advanced Network Security for 5G, Future generation network design

Professionally Used Software: Matlab/Simulink

Project work/Assignment:

1. Project Assignment: Compare the performance of different network security algorithms using Matlab. A final report and presentation are required.

2. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.**Presidency University Library Link .**

3.Assignment : Perform DES algorithm using Matlab or Simulink

Reference(s):

Reference Book(s):

1 Mao, "Modern cryptography: Theory and Practice", Pearson education 2003, Edition 1

2. Behrouz A Forouzan, "Cryptography and Network Security", TMH, 2008, Publisher: Tata Mcgraw-Hill, New Delhi India. Edition: 1

Online Resources (e-books, notes, ppts, video lectures etc.):

4. NPTEL video lecture on "Cryptography and Network Security" by IIT Kharagpur, Dr. Debdeep Mukhopadhyay https://nptel.ac.in/courses/106105031
5. NPTEL video lecture on "Cryptography and Network Security" by IIT Kharagpur, Prof. Sourav Mukhopadhyay https://onlinecourses.nptel.ac.in/noc21_cs16/
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

4. Abdalbasit Mohammed Qadir,Nurhayat Varol, "A review paper on cryptography", Published in: 2019 7th International Symposium on Digital Forensics and Security (ISDFS). 10.1109/ISDFS.2019.8757514
5. T. Rajani Devi, "Importance of Cryptography and Network Security", Published in: 2013 International Conference on Communication Systems and Network Technologies 10.1109/CSNT.2013.102

Topics relevant to "EMPLOYABILITY": Data encryption algorithms and standards, security threats for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Amrutha V Nair
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3060	**Course Title: Wireless Adhoc Networks** **Type of Course: : Discipline Elective- Data Transfer Technologies Basket**	**L-T- P-C**	**3**	**0**	**0**	**3**
Version No.	**2.0**					
Course Pre-requisites	**Wireless Communication and Networks, Wireless topologies and protocols**					
Anti-requisites	**NIL**					
Course Description	This course is an advanced research-oriented course designed for under graduate students with computer and wireless networks background. The course will act as foundation for Mobile Ad Hoc Networks (MANETs), Wireless Sensor Networks (WSNs) and Wireless Mesh Networks (WMNs). The course examines wireless cellular, ad hoc and sensor networks, covering topics such as medium access control, network and transport protocols, unicast and multicast routing algorithms, mobility and its impact on routing protocols, application performance, quality of service guarantees, and security.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques using open source Design Tools.					
Course Outcomes	On successful completion of the course students shall be able to: 1. Explain fundamental principles of Ad-hoc Networks 2. Discuss a comprehensive understanding of Ad-hoc network protocols 3. Outline current and emerging trends in Ad-hoc Wireless Networks 4. Analyze energy management in ad-hoc wireless networks.					
Course Content:						
Module 1	**MAC Protocols**	Assignment / Quiz	Comprehension based Quizzes and assignments; simulation with MATLAB			10 Sessions
Topics: Introduction, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention – Based Protocols, Contention – Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.						
Module 2	**Routing Protocols**	Assignment	Network simulation Task and Analysis			09 Sessions
Topics: Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms,						

Hierarchical Routing Protocols, Power – Aware Routing Protocols.				
Module 3	**Transport Layer Protocols**	Assignment and Lab projects with presentation	Project implementations in software and presentations	10 Sessions
Topics : Issues in designing a transport layer protocol for ad hoc wireless network, transport layer solutions Security in ad hoc wireless networks, network security requirements, issues and challenges in security provisioning, network security attacks				
Module 4	**Quality of Service and Energy Management in Ad-hoc Wireless Networks**	Project	Project implementations in software and presentations	10 Sessions
Topics: Introduction, Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions; Energy Management in Ad-hoc Wireless Networks: Introduction, Need for Energy Management in Ad-hoc Wireless Networks, Classification of Energy Management Schemes, Battery Management Schemes, Transmission Management Schemes, System Power Management Schemes.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Professionally Used Software: Network simulator2/OPNET/Matlab, Arduino **Targeted Application:** Wireless Adhoc Network in Ultra wide band radio communication- Wireless fidelity systems. Accessing the Internet, Locating and Tracking-GPS, security systems, television remote control, computer-interface devices, Wi-Fi, wireless power transfer and many projects based on mobile communications are applications of mobile communication. **Enhance Security:** The different types of wireless communication can enhance security. For example, walkie-talkies transmit and receive radio signals				
Project work/Assignment/Quiz:				
Project Assignment: Consider a wireless network where the transmission is going on between nodes A & B that are separated by a distance d and the transmission range of each node is R. **Assignment 1:** Collect the data for a network traffic and calculate the percentage of packet drop and packets delivered successfully. **Assignment 2:** Calculate the probability of data packet collision in the MACA protocol. Assume that T_c is the control packet transmission propagation delay, T_w is the optimal maximum back-off time, β is the percentage of ready nodes, & R is the transmission range of each node. **Assignment 3:** Assuming that all routers and hosts are working properly and that all software in both is free of all errors, is there any chance, however small, that a packet will be delivered to the wrong destination? **Assignment 4:** Calculate the probability of data packet collision in the MACA protocol. Assume that T_c is the control packet transmission propagation delay, T_w is the optimal maximum back-off time, β is the percentage of ready nodes, & R is the transmission range of each node.				

Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format **Presidency University Library Link .**

Text Book(s):

C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education India; 1st edition 2006, PHI.

Reference(s):

1. Roy Blake, "Wireless Communication Technology", First Edition CENGAGE, 2012
2. Jagannathan Sarangapani, "Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control" Second Edition CRC Press.
3. Ozan K. Tonguz and Gianguigi Ferrari: Ad-hoc Wireless Networks, John Wiley, 2007.
4. Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du: Ad-hoc Wireless Networking, Kluwer Academic Publishers, 2004.
5. C.K. Toh: Ad-hoc Mobile Wireless Networks- Protocols and Systems, Pearson Education, 2002

Online and Web resource (s):

1. Archive.cone.informatik.uni-freiburg.de/.../lecture/.../MANET-01.ppt
2. www.rimtengg.com/coit2007/proceedings/pdfs/122.pdf
3. people.cs.vt.edu/~irchen/6204/.../lecture4-mobile-ad-hoc-networks
4. https://nptel.ac.in/courses/106/105/106105160/
5. https://www.coursera.org/lecture/internet-of-things-history/sensor-networks-n-to-1-iOmzK
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content:

1. Wireless Sensor Network as a Mesh: Vision and Challenges by Zhanserik Nurlan, Tamara Zhukabayeva, Mohamed Othman, Aigul Adamova, And Nurkhat Zhakiyev, Digital Object Identifier 10.1109/ACCESS.2021.3137341.
2. Using Overhearing and Rateless Coding in Disseminating Various Messages in Vehicular AdHoc Networks by Mostafa Nozari, Faramarz Hendessi, Nadia H. Khiadani, And Maryam Ataei Kachooei, Digital Object Identifier 10.1109/ACCESS.2021.3110945.
3. Reliability-Aware Multi-Objective Optimization-Based Routing Protocol for VANETs Using Enhanced Gaussian Mutation Harmony Searching by Sami Abduljabbar Rashid1, Mohammed Alhartomi, Lukman Audah and Mustafa Maad Hamdi, Digital Object Identifier 10.1109/ACCESS.2022.3155632
4. Adaptive Routing Design for Flying Ad Hoc Networks Min Zhang, Chao Dong, Peng Yang, Ting Tao, Qihui Wu and Tony Q. S. Quek, IEEE Communications Letters, Vol. 26, NO. 6, June 2022 Https://Ieeexplore.Ieee.Org/Document/9716929.

Topics related to development of "FOUNDATION": MAC Protocols, Energy Management in Ad-hoc Wireless Networks

Topics related to development of "EMPLOYABILITY": Security in ad hoc wireless networks, network security requirements, issues and challenges in security provisioning, network security attacks

Topics related to development of "ENTREPRENEURSHIP": Battery Management Schemes, Transmission Management Schemes, System Power Management Schemes

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": MAC

Protocols that use Directional Antennas**,** LAN's, Wi-Fi, Wi-Max.	
Catalogue prepared by	Ms. Maitraiyee Konar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3061	**Course Title: Optical Communication Type of Course: : Discipline Elective- Data Transfer Technologies Basket**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of electronic devices, digital modulation and demodulation schemes, analog modulation and demodulation schemes, probability theory.					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to learn the basic principle of optical fiber communication and also understand the transmission characteristics and losses in a wireless communication system. The course will act as a harbinger for exponentially growing modern communication systems. The course emphasizes on working, analysis and design of wireless communication system. Additionally, this course will create a foundation for future courses such as Radar Communication and Free Space Communication etc.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Optical Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	**On successful completion of this course the students shall be able to:** (1) Explain the basic concepts of optical Engineering (2) Apply the active, passive devices and optical amplifiers in optical wireless networks. (3) Analyze an optical wireless communication system. (4) Apply advanced concepts of optical Engineering to design and develop more efficient next generation optical wireless communication systems.					
Course Content:						
Module 1	**Introduction to optical wireless communication systems**	Quiz	Memory Recall based Quizzes	**10 Sessions**		
Topics: Wireless Access Schemes, Brief History of OWC, OWC/Radio Comparison, WC Application Areas, Safety and Regulations, OWC Challenges.						
Module 2	**Fluctuation Theory**	Assignment	Design oriented	**10 Sessions**		
Topics: Scintillation Theory-Plane Wave Model, Scintillation Theory-Spherical Wave Model, Wave ModelDistribution Models for the Irradiance[introduction].						
Module 3	**Modulation Techniques**	Assignment	Design Analysis	**10 Sessions**		
Topics Introduction, Analogue Intensity Modulation, Digital Baseband Modulation Technique Pulse Position Modulation, On–Off Keying.						
Module 4	**OPTICAL RECEIVER**	Assignment	Application based	**9**		

			analysis	**Sessions**

Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver operation, Analog receivers.

Targeted Application & Tools that can be used:

Tools: Matlab

Project work/Assignment:

Project Assignment:

1. Create a simple network model with multiple scenarios, collect statistics on network performance through the use of simulation tools, analyse statistics and draw conclusions on network performance.
2. Establish aFree space optical communication link.
3. Compare the Bit Error Rate for various weather conditions.

Text Book

1.Gerd Keiser, "Optical Fiber Communications" McGraw-Hill, 5th Edition, 2013

References

7. **G.P Agrawal, Fiber Optic Communication Systems, Wiley, ISBN 0470505117**
8. **R.G feller and U. Bapst. Wireless in-house communication via diffuse infrared radiation, SPIE Press**
9. **S. Hranilovic. Spectrally Efficient Signalling for Wireless Optical Intensity Channels. PhD thesis, Dept. of Elec. & Comp. Engineering, University of Toronto, 2003.**

Online Resources & E-content(e-books, notes, ppts, video lectures etc.):

NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview

COURSERA - https://www.coursera.org/specializations/optical-engineering.

Presidency University Library Link https://presiuniv.knimbus.com/user#/home

ResearchPapers :

1. Weik, M.H. (2000). integrated fiber optic communications system. In: Computer Science and Communications Dictionary. Springer.**https://doi.org/10.1007/1-4020-0613-6_9232**
2. Weik, M.H. (2000). fiber optic communications system. In: Computer Science and Communications Dictionary. Springer. **https://doi.org/10.1007/1-4020-0613-6_9221**
3. 1P. Qiao, G. Su, Y. Rao, C. J. Chang-Hasnain and S. L. Chuang, "Modeling of long-wavelength high contrast grating VCSELs and comparison with experiment," *CLEO: 2013*, 2013, pp. 1-2.
4. Guan-Lin Su, Pengfei Qiao, C. -Y. Lu, D. Bimberg and S. L. Chuang, "Low-threshold dielectric-cavity microlasers," *2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications*, 2014, pp. 1-2.

Topics relevant to "EMPLOYABILITY": Fiber Optic Communication Systems for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Balaji K A
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3099	**Course Title: Modern Wireless Communication with 5G** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital communications, Mobile Communication Systems, Wireless Networks					
Anti-requisites	NIL					
Course Description	The aim of this course is to let the students understand that air Interface is one of the most important elements that differentiate between 2G, 3G, 4G and 5G. While 3G was CDMA based, 4G was OFDMA based; this course reveals the contents of air interface for 5G. While 4G brought in a deluge of infotainment services, 5G aims to provide extremely low delay services, great service in crowd, enhanced mobile broadband (virtual reality being made real), ultra-reliable and secure connectivity, ubiquitous QoS, and highly energy efficient networks.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using MATLAB tools.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Learn 5G Technology advances and their benefits 2. Learn the key RF, PHY, MAC and air interface changes required to support 5G 3. Learn Device to device communication and millimeter wave communication 4. Implementation options for 5G					
Course Content:						
Module 1	**Overview of 5G Broadband Wireless Communications**	Assignment/ Quiz	Memory Recall based Quizzes	**15 Sessions**		
Topics: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.						
Module 2	**The 5G wireless Propagation Channels**	Assignment/ Quiz	Real time Application Project	**15 Sessions**		
Topics: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mmWave MIMO Systems.						
Module 3	**Transmission and Design Techniques for 5G**	Assignment/ Quiz	Memory Recall based Quizzes	**10 Sessions**		
Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized						

frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).				
Module 4	**Device-to-Device (D2D) Communications**	Assignment/ Quiz	Memory Recall based Quizzes	**10 Sessions**

Topics:
Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.

Targeted Application & Tools that can be used:
Networked embedded systems appear in a variety of application domains such as automotive, train, aircraft, office building, and industrial areas—primarily for monitoring and control.
Professionally Used Software: MATLAB

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based on automated access control and access management area, Networked Embedded Identification Systems with fingerprint and RFID sensors as a case study. Students will be submitting a report on the same which will include in appropriate format.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
4. Project Assignments:

Text Book(s):

1. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, "*5G Mobile and Wireless Communications Technology"*, Cambridge University Press, 2011. Second Edition.
2. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "*New Directions in Wireless Communication Systems from Mobile to 5G*", CRC Press, 2017.

Reference(s):
Reference Book(s):

R1 Erik Dahlman, Stefan Parkvall, Johan Skold , " *5G NR: The Next Generation Wireless Access Technology "*, Elsevier, 2016, First Edition.

R2 Jonathan Rodriguez, "*Fundamentals of 5G Mobile Networks*", Wiley, 2010. First Edition.

R3 Claude Oestges, Bruno Clerckx, "*MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design"*, Academic Press, 2010, First Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video Lectures on "Evolution of Air Interface towards 5G" by Prof. Suvra Sekhar Das, IIT Kharagpur.
https://nptel.ac.in/courses/108105134
2.Video Lectures on "5G Mobile Networks: Modern Wireless Communication" by TELCOMA
https://www.udemy.com/course/5g-mobile-networks-modern-wireless-communication-technology/

E-content:

1. Khalid, N., & Akan, O. B. (2016). Experimental throughput analysis of low-THz MIMO communication channel in 5G wireless networks. IEEE Wireless Communications Letters, 5(6), 616-619.
https://ieeexplore.ieee.org/document/7562539
2. P. Xingdong, H. Wei, Y. Tianyang and L. Linsheng, "Design and implementation of an active multibeam antenna system with 64 RF channels and 256 antenna elements for massive MIMO application in 5G wireless communications," in China Communications, vol. 11, no. 11, pp. 16-23, Nov. 2014, doi: 10.1109/CC.2014.7004520.
https://ieeexplore.ieee.org/document/7004520
3. J. Huang, C. -X. Wang, H. Chang, J. Sun and X. Gao, "Multi-Frequency Multi-Scenario Millimeter Wave MIMO Channel Measurements and Modeling for B5G Wireless Communication Systems," in IEEE Journal on Selected Areas in Communications, vol. 38, no. 9, pp. 2010-2025, Sept. 2020, doi: 10.1109/JSAC.2020.3000839.
https://ieeexplore.ieee.org/document/9112246

Topics relevant to the: "FOUNDATION SKILLS", Wireless Communication
Topics relevant to the:" EMPLOYABILITY", MIMO Systems
Topics related to development of "ENTREPRENEURSHIP": Software Defined Radio
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Application of 5G Communication.

Catalogue prepared by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3100**	**Course Title: Underwater Communication** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**		**L- T- P- C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Digital Communication Systems						
Anti-requisites	NIL						
Course Description	This course deals with the three main application areas of Network Embedded Systems – Wireless Sensor Networks, Automotive, and Industrial Automation and relatively new subtopic of Home Automation.						
Course Objective	The objective of the course is SKILL DEVELOPMENT of the student by using PARTICIPATIVE LEARNING techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Discuss the concepts of sound waves 2. Design underwater signal processing systems 3. Analyze the performance of underwater signal processing systems 4. Outline the oceanography and sensors in the underwater system						
Course Content:							
Module 1	**Fundamentals of Underwater Acoustics**	Assignment/ Quiz	Memory Recall based Quizzes	**9 Sessions**			
Topics: The Ocean acoustic environment, measuring sound level, Sources and receivers, relevant units, sound velocity in sea water, typical vertical profiles of sound velocity, Sound propagation in the Ocean- characteristic sound propagation paths-deep water and shallow water, Range dependent environment. Sound attenuation in sea water, Bottom Loss, Surface bottom loss and volume scattering, Snell's law for range dependent Ocean.							
Module 2	**Characteristics of Sonar systems**	Assignment/ Quiz	Real time Application Project	**9 Sessions**			
Sonar systems, active and passive sonar equations, transducers and their directivities, Sensor array characteristics-array gain, receiving directivity index, beam patterns, shading and super directivity, adaptive beamforming							
Module 3	**Various Underwater Sensors**	Assignment/ Quiz	Memory Recall based Quizzes	**9 Sessions**			
Sonars – Active & passive sonars, hydrophones, DAS, ROV, AUV, Sidescan sonar, Echo sounder, MBEC, Sub bottom profiler, magnetometer, dredger, sensors application in shallow water and deep water.							
Module 4	**Underwater Noises and Oceanographic Instrumentation**	Assignment/ Quiz	Memory Recall based Quizzes	**13 Sessions**			

Basic Concept of noises in underwater- Types of noises — natural, man-made, ambient noise types -seismic, wind, biological, lobsters, dolphin, shipping, turbulence noise, rain etc., Descriptions of research vessels, cruise, position fixing in the sea; sampling devices — Grab samplers, bottom samplers, dredges, sediment traps, boomerang samplers, water samplers, Winches, temperature measurement instruments, tools for studying ocean floor topography.

Targeted Application & Tools that can be used:
Underwater communication appears in a variety of applications such as detection of the objects on the ocean floor, used in environmental monitoring and collecting of oceanographic information, used in seismic monitoring, pollution monitoring and ocean currents monitoring, used in environmental monitoring like climate recording, pollution control, prediction of natural disaster harbor protection, also in autonomous underwater vehicles.
Professionally Used Software: UWSim, MATLAB, NS2

Project Work/Assignment:

1. Case Studies: At the end of the course students will be able to study the location-based noises and comparison between various noises in underwater. Students will be submitting a report on the same which will include in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignments:
The ocean is the heart of the planet, as it affects the planet's climate on a global scale and provides countless resources and benefits to all of the creatures that live on Earth. The technology of underwater communications and networking can greatly enhance human's ability to study, monitor, explore, and protect the planet's precious aquatic environment. However, the unique characteristics under the surface of the sea present grand challenges to the development of wireless communication and networking systems, including a harsh environment, severe attenuation, multipath dispersion, Doppler shift, mobility, link and topology dynamics, and so on.
Assignment 1: Survey of Underwater wireless communication technologies

Assignment 2: Research Challenges and Applications for Underwater Sensor Networking

Text Book(s):
1. Yi Lou Niaz Ahmed, "Underwater Communications and Networks", Springer, 2021.

Reference(s):
Reference Book(s):

R1 Robert J Urick, "*Principles of Underwater Sound*", Peninsula Publishing, Third Edition, 1983 Cambridge University Press.

R2 Clarence S.Clay, "*Acoustical Oceanography: Principles and Applications*", Wiley-Blackwell, 1977.

R3 M. Grant Gross "*Principles of Oceanography",* Pearson College Div, Subsequent edition, 1995.

Online Resources (e-books, notes, ppts, video lectures etc.):
1. https://www.ntnu.edu/studies/courses/TTT4175#tab=omEmnet
2. https://en.wikipedia.org/wiki/Underwater_acoustic_communication

E-content:

1. H. Kaushal and G. Kaddoum, "Underwater Optical Wireless Communication," in IEEE Access, vol. 4, pp. 1518-1547, 2016, doi: 10.1109/ACCESS.2016.2552538. https://ieeexplore.ieee.org/abstract/document/7450595/
2. Z. Sun, H. Guo and I. F. Akyildiz, "High-data-rate Long-range Underwater Communications via Acoustic Reconfigurable Intelligent Surfaces," in IEEE Communications Magazine, doi: 10.1109/MCOM.002.2200058. https://ieeexplore.ieee.org/document/9833455
3. I. F. Akyildiz, P. Wang and Z. Sun, "Realizing underwater communication through magnetic induction," in IEEE Communications Magazine, vol. 53, no. 11, pp. 42-48, November 2015, doi: 10.1109/MCOM.2015.7321970.

Topics relevant to the: "FOUNDATION SKILLS", Fundamentals of underwater acoustics.
Topics relevant to the:" EMPLOYABILITY", Sonar systems and underwater sensors.

Catalogue prepared by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: ECE3104	**Course Title:Vehicle To Vehicle Communication** **Type of Course: Discipline Elective- Data Transfer Technologies Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic Knowledge on wireless communications, computer networks and mobile ad-hoc networks, Embedded systems.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of vehicle to vehicle communication based systems with IOT as its base. The course develops the knowledge of both hardware and software that leads to the design and implementation Real time automated Applications in industrial level.The course emphasizes on vehicle to vehicle communication technology on different types of networks like ADHOC wireless networks etc, highlighting the practical methodology, testability, and design verification in real time applications. The course also demonstrates the use of many software languages and platforms that supports develop designs for high level synthesis and simulation.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Vehicle To Vehicle Communication and attain ENTREPRENEURSHIP SKILLS through PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand and describe the basic theories and principles, technologies, standards, and system architecture of vehicular ad-hoc networks (VANET) or inter-vehicle communication networks 2. Analyze vehicular communication platforms for various kinds of safety and infotainment applications. 3. Assimilate new technological development in related fields. 4. Communicate effectively between different vehicles using the related technologies. 5. Develop a detail understanding of how vehicle communicate to other vehicles and to infrastructure over DSRC.					
Course Content:						
Module 1	**Introduction & Cooperative Vehicular Safety Applications**	Group Presentation	Memory Recall based Quizzes	**10 sessions**		
Topics: Basic principles and challenges, : Introduction to VANET,past and ongoing VANET activities, Enabling technologies, cooperative system architecture, safety applications. Introduction to DSRC and BSM.						
Module 2	**Vehicular Mobility Modeling**	Group Presentation	Memory Recall based Quizzes	**10 sessions**		
Topics: **Vehicular Mobility Modeling** :						

Vehicle Safety Communication - Apps (VSC-A), Random models, flow and traffic models, behavioral models, trace and survey-based models, joint transport and communication simulations .

Physical Layer Considerations for Vehicular Communications:

Signal propagation, Doppler spread and its impact on OFDM systems.

Module 3	**MAC Layer of Vehicular Communication Networks & VANET Routing protocols**	Group Presentation	Memory Recall based Quizzes	**10 sessions**

Topics:

MAC Layer of Vehicular Communication Networks :

Proposed MAC approaches and standards, IEEE 802.11p, Connected Vehicles& Connected Autonomous Vehicles, Dedicated Short Range Communication, :WAVE Physical Layer, WAVE MAC Layer WAVE Upper Layer.

VANET Routing protocols:

Vehicle to Infrastructure Safety Applications, DSRC Scalability,Opportunistic packet forwarding, topology-based routing, geographic routing, :Security and Privacy.

Module 4	**Emerging VANET Applications & Standards and Regulations**	Group Presentation	Memory Recall based Quizzes	**10 sessions**

Topics:

Emerging VANET Applications :

Limitations, example applications, communication paradigms, message coding and composition, data aggregation,WIMAX technology ,LI-FI technology and some practical design examples.

Standards and Regulations:

Regulations and Standards, DSRC Protocol Stack, Cellular V2X.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications - Data analytics, Network and Structure, Protection, Device and Hardware, Cell and UI development, Cloud management,Network Security,traffic managers, Automated locomotives .

Professionally Used Software - Autosar basic software (BSW) operating system, real-time operating systems such as Nucleus RTOS, and Linux container (LXC),secure communication is enabled using protocols such as Remote Processor Messaging (RPMsg) and VirtIO .Other softwares -MATLAB, Embedded-C/C++ and Python,,Keil software.

Text Book(s):

1. H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and InterNetworking Technologies, Wiley, 2010.
2. Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communications A Technical Approach1st EditionEdited By Fei Hu, Copyright Year 2018 ISBN 9780367572020,Published June 30, 2020 by CRC Press
3. .Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy",John Wiley & Sons Ltd1st Edition 2012.

Reference(s):

1. P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.
2. C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.
3. M. Emmelmann, B. Bochow and C. C. Kellum, Vehicular Networking: Automotive Applications and Beyond, Wiley, 2010.

4. M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information Science Reference, 2010.
5. H. Moustafa, Y. Zhang, Vehicular Networks: Techniques, Standards, and Applications, CRC Press, 2009.
Others: 1. IEEE Transactions and other journals.

Online Resources (e-books, notes, ppts, video lectures etc.):

1.NHTSA: https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communication

2.Coursera: https://www.coursera.org/lecture/internet-of-things-history/iot-automotive-0vJj5

3.Udemy: https://www.udemy.com/course/c-v2x-cellular-vehicle-to-everything-5g/

4.Free online self-paced course :- https://open.cs.uwaterloo.ca/python-from-scratch/

5.Online notes :- https://open.cs.uwaterloo.ca/language-independent-lessons/

6. https://presiuniv.knimbus.com/user#/home

E-content:

1. VEHICLE TO VEHICLE COMMUNICATION USING LIGHT FIDELITY By Annapurna H.S*1, Magesh.K*2, Nanda Kumar.K*3, Ruchith Gururaj*4, Shalini.S*5, Sri Sai Chandana*6 *1,2,3,4,5UGC, Electronic and communication, Presidency University, Bangalore, Karnataka, India *6Assistant Professor, Department of ECE Engineering, Presidency University, Bangalore, Karnataka, India. **https://www.irjmets.com/uploadedfiles/paper//issue_6_june_2022/26090/final/fin_irjmets1655395717.pdf**
2. Vehicle to vehicle communication :Dedicated short Range Communication and safety Awareness by Y. A. Vershinin and Y. Zhan, "Vehicle to Vehicle Communication: Dedicated Short Range Communication and Safety Awareness," *2020 Systems of Signals Generating and Processing in the Field of on Board Communications*, 2020, pp. 1-6, doi: 10.1109/IEEECONF48371.2020.9078660 **https://ieeexplore.ieee.org/servlet/opac?mdnumber=EW1586.**
3. Vehicle-to-Vehicle Communication Technology IEEE Albert Demba; Dietmar P. F. Möller 2018 IEEE International Conference on Electro/Information Technology (EIT)Date of Conference: 03-05 May 2018Date Added to IEEE Xplore: 21 October 2018ISBN Information:ISSN Information:INSPEC Accession Number: 18183552 DOI: 10.1109/EIT.2018.8500189 Publisher: IEEE Conference Location: Rochester, MI, USA **https://ieeexplore.ieee.org/document/8500189**
4. Bidirectional Vehicle-to-Vehicle Communication System Based on VLC: M. Meucci, M. Seminara, T. Nawaz, S. Caputo, L. Mucchi and J. Catani, "Bidirectional Vehicle-to-Vehicle Communication System Based on VLC: Outdoor Tests and Performance Analysis," in *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 8, pp. 11465-11475, Aug. 2022, doi: 10.1109/TITS.2021.3104498.**https://ieeexplore.ieee.org/document/9522077/authors**
5. Performance of Vehicle-to-Vehicle Communication using IEEE 802.11p in Vehicular Ad-hoc Network Environment by Ellipsometer P. S. Hauge and F. H. Dill, "Design and Operation of ETA, an Automated Ellipsometer," in IBM Journal of Research and Development, vol. 17,no.6,pp.472-489,Nov.1973,doi:10.1147/rd.176.0472. **https://arxiv.org/abs/1304.3357**

Topics related to development of "FOUNDATION": MAC Layer of Vehicular Communication Networks, VANET Routing protocols Topics related to development of "EMPLOYABILITY": Emerging VANET Applications , DSRC Protocol Stack Topics related to development of "ENTREPRENEURSHIP": Vehicle to Infrastructure Safety Applications Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Enabling technologies, cooperative system architecture, safety applications Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": safety applications	
Catalogue prepared by	Mrs.Annapurna.H.S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

AI and Wearable Technologies Basket

Course Code: **ECE3062**	**Course Title: Fundamentals of Wearable Sensing** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic knowledge in Wireless Communication					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand measurement and instrumentation systems that are used in wearable sensors. This course is analytical in nature and provides a good knowledge about the construction of testing and measuring setup for wearable sensing systems. The course is beneficial in the design of resistive sensors, reactive sensors and self-generating sensors and its applications in real life scenarios that would be worn on body.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques using virtual testing through simulation.					
Course Outcomes	On successful completion of the course students shall be able to: 1. Demonstrate the concept of resistive and reactive sensors which can be applied for real life applications. 2. Understand the working principle of special purpose sensors and the need for developing smart sensors. 3. Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals. 4. Perform experimental study of various sensors.					
Course Content:						
Module 1	**Resistive and Reactive Sensors**	Assignment	Case study based		**08 Classes**	
Topics: Overview of Measurement System, Instruments and errors in sensing systems. Resistive sensors- Potentiometers, strain gages (piezo-resistive effect), resistive temperature detectors (RTD), thermistors, magneto- resistors, light dependent resistor (LDR), resistive hygrometers, resistive gas sensors. Wearable applications: Strain sensor for monitoring Physiological signals, body movement.						
Module 2	**Smart Sensors and Applications**	Project	Small hardware based		**09 Classes**	
Topics: Integrated and Smart sensors, IEEE 1451 standard & Transducer Electronic Datasheets (TEDs), Overview of various smart sensors: Digital temperature sensor (DS1621, TMP36GZ), Humidity sensor (DHT11, DHT22, FC28), IR sensor (FC51), Gas sensor (MQ2,MQ8), Pressure sensors (BMP180), Accelerometers (ADXL335), etc, Structural health monitoring sensors, Introduction to MEMS and Flexible sensors.						

Module 3	Scope of Wearable Devices	Assignment	Small hardware based	08 Classes

Topics:
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Wearable and noninvasive assistive technologies, Detection and Characterization of food intake by wearable sensors, Wearing sensors inside and outside of the Human body for early detection of diseases.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: :

1. Fabrication of interdigitated (IDE) electrodes**.**
2. Piezoresistive sensors for cuffless blood pressure measurement.
3. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.
4. Smart textile for neurological rehabilitation system (NRS)
5. Epidermal electronics system (EES)
6. 3D imaging and motion capture
7. safety and security, navigation, Enhancing sports media, Automatic digital diary
8. AI for respiratory diagnostics and clinical trials.

Professionally Used Software: python/C,C++, **Virtual testing through simulation in ANSYS software.**

Project work/Assignment/Quiz:

1. Case Studies: At the end of the course students will be given a 'real-world' Wearable application based devices etc. as a case study. Students will be submitting a report which will include Block/Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Text Book(s):

1 "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, Academic Press/Elsevier, ISBN 978-0124186620, Edward Sazonov, Michael R. Neuman (editors), 2nd edition.

Reference(s):

Reference Book(s):

1 "Wearable Electronics Sensors-For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015

2 M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018.

3 "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal,Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK

2. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT
3. https://nptel.ac.in/courses/112/107/112107289/
4. https://nptel.ac.in/courses/112/105/112105249/
5. https://www.intechopen.com/chapters/66880
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content: (Presidency University E-resources)

1. https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications
2. https://www.intechopen.com/books/5408
3. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w
4. https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/
5. https://www.mdpi.com/books/pdfview/book/1088

Topics related to development of "EMPLOYABILITY": Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, and Health monitoring sensors. Students will learn various sensors and their broad applications from employability skills.

Catalogue prepared by	Mrs. Amrutha V Nair
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3063**	**Course Title: Wearable Devices and its Applications** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Fundamentals of Wireless Communication					
Anti-requisites	NIL					
Course Description	The objective of this course is to make the students to understand the need for development of wearable devices and its implications on various ssectors. It will also comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. The course will enable the students to become acquainted with various wearable locomotive sensors as assistive devices for tracking and navigation. This course also helps in carrying out research and development activities or employment opportunities in the area of wearable devices.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wearable Devices and its Applications and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of the course students shall be able to: 1. Identify and understand the need for development of wearable devices and their influence on various sectors. 2. Discuss the applications of various wearable inertial sensors for biomedical applications. 3. Identify the use of various wearable locomotive tools for safety, security and navigation. 4. Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistivedevices.					
Course Content:						
Module 1	**IntroductiontoWearable Devices**	Quiz	Memory Recall based Quiz	**09 Classes**		
Topics: Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sector overview–sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry,public sector and safety.						
Module 2	**WearableInertialSensors**	Assignment	Case study based	**08Classes**		
Topics: Wearable Inertial Sensors- Accelerometers,Gyroscopic sensors and Magnetic sensors; Modality of Measurement-Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection, Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients.Physical Activity monitoring:						

Human Kinetics,Cardiac Activity, EnergyExpenditure measurement: Pedometers, Altigraphs.				
Module 3	**WearableCamerasandMicrophonesforNavigation**	Project	Small hardware based	**14Classes**
Topics: Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sportsmedia, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices forFingers and Hands, Assistive Devices for wrist, forearmand-feet, vests and belts, head-mounteddevices.				
Module 4	**Other Applications**	Assignment		**08 Classes**
Topics: Wearables for life in space: Life on Moon and Mars, Optical cardiovascular Monitoring, Bioimpedance systems for home care monitoring using BSNs: the IPANEMA BSN, Fatigue monitoring techniques: Methods and wearables.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: **Targeted Applications:** **1.** Fabrication of inter digitated (IDE) electrodes**.** **2.** Piezoresistive sensors for cuffless blood pressuremeasurement. **3.** Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring. **4.** Smarttextileforneurologicalrehabilitationsystem(NRS) Professionally Used Software: ANSYS software, python/C,C++				
Project work/Assignment/Quiz: 1. Students will be made into groups and given programming assignments at the end of each module. Students need to use MULTISIM for these assignments. 2. Book Review/ Article review: A chapter of abook or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. 3. Presentation: There will be a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.				
Text Book(s): **1 "**Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018, 1st edition **2 "**WearableSensors-Fundamentals,ImplementationandApplications",byEdwardSazonovand Michael R. Neuman, ElsevierInc., 2014, 2nd edition				
Reference(s): **Reference Book(s):** 1. Wearable Electronics Sensors – For Safe and Healthy Living",Subhas Chandra Mukhopadhyay, Springer 2015 2. M**.**Mardonova and Y. Choi,"Review of Wearable Device Technology and Its Applications to the Mining Industry,"Energies, vol.11, p. 547, 2018. 3. Environmental, Chemical and Medical Sensors",by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018 Online Lectures: 1. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK 2. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT 3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-Content: (Presidency University E-resources)				

1. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w 2. https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/ 3. https://www.mdpi.com/books/pdfview/book/1088	
Topics relevant to "EMPLOYABILITY": Design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications, Wearable devices with Global Positioning System (GPS) integration for tracking and navigation, Wearable Optical Sensors EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Ms. Amrutha V Nair
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code: ECE3064</td><td colspan="3">Course Title:Embedded Platforms for Wearables
Type of Course: Discipline Elective- AI and Wearable Technologies Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">Microprocessor, Microcontroller, Fundamentals of Wearable Sensing</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The objective of this course is to introduce concepts of wearable embedded system design and the insight of various ARM Cortex architectures and its applications in various areas of wearable computing and to introduce the I/O interfacing with ARM Cortex architectures.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is to familiarize the learners with the concepts of Embedded Platforms for Wearables and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
1) Understand design issues of wearable embedded system design
2) Explore various ARM processor architectures for wearable applications
3) Program ARM Cortex architecture using assembly and C programming
4) Interface I/O peripherals with ARM Cortex</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Wearable Embedded Systems</td><td>Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">06session</td></tr>
<tr><td colspan="9">Topics:
Introduction to wearable embedded systems, Challenges in the design of wearable embedded system design, Design Methodology for wearable embedded systems, Selection criteria of embedded processor for wearable embedded systems, Application areas of wearable embedded systems.</td></tr>
<tr><td>Module 2</td><td colspan="2">Wearable Embedded Architectures</td><td>Assignment / Quiz</td><td colspan="2">Programming and Simulation task / Memory Recall based Quizzes</td><td colspan="2">10 session</td></tr>
<tr><td colspan="9">Topics:
Features of ARM Cortex Series, Comparison of ARM Cortex-M and Cortex-A architectures, addressing modes, ARM instruction set for ARM Cortex.</td></tr>
<tr><td>Module 3</td><td colspan="2">Programming Embedded Architecture and Interfacing</td><td>Assignment / Quiz</td><td colspan="2">Programming and Simulation task / Memory Recall based Quizzes</td><td colspan="2">12 session</td></tr>
<tr><td colspan="9">Topics: Assembly language Programming, Embedded C Programming, Code Density and Thumb Mode in ARM, Power Control in ARM, Interrupt structure of ARM Cortex architecture, Interfacing with ARM Cortex: - LED, LCD, Keypad, PWM Programming, Communication Protocols: - Bluetooth, USB, CAN BUS, MOD BUS, UART, I2C.</td></tr>
<tr><td>Module 4</td><td colspan="2">Case Studies</td><td>Assignment</td><td colspan="2">Programming Assignment</td><td colspan="2">12 session</td></tr>
</table>

Topics:
Various case studies of wearable system design:- Wearable Smart Watch, Hearing Aid for person with disability, Body parameter measurement in medical field, agricultural monitoring devices etc.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Biomedical Embedded Systems Design, Wearable gadget design and development

Professionally Used Software: ARM Keil uVision-5, Code Composer Studio (CCS)

Project Work/Assignment:

1. Case Study: At the end of the course students will be given a 'real-world' application-based on wearable embedded system as a case study. Students will be submitting a report which will include Application Design, sensors used, middleware protocols used and working mechanism etc. in appropriate format.

2Book/Article review: At the end of the course a literature review of any 01 recent articles from the reputed national and international journal/ conferences will be given by students. They need to refer to tools like Scopus/ Google-Scholar and submit a report on their understanding of the assigned article in appropriate format.

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to present their review work.

Text Book(s):

1. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 1st edition
2. Frank Vahid, Tony Givargis, "Embedded System Design: Unified Hardware/Software Design", John Wiley & Sons,2nd Edition,

Reference(s):

Reference Book(s):

1. Enzo Pasquale Scilingo, Gaetano Valenza, "Wearable Electronics and Embedded Computing Systems for Biomedical Applications", MDPI AG, Switzerland, 1st Edition
2. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition
3. ARM Cortex Datasheet available on (https://www.arm.com/)

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Online NPTEL course :- https://onlinecourses.nptel.ac.in/noc22_ee12/preview
2. Notes:https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/third-party/ddi0100e_arm_arm.pdf
3. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html
4. https://presiuniv.knimbus.com/user#/home

E-content:

1. Jin-Ho Yoo, Hyun-Tae Jeong, Yeon Cho, "A Study On The Wearable Embedded System Platform",The Journal of Korean Institute of Communications and Information Sciences, 2005 https://www.researchgate.net/publication/264114985_A_Study_On_The_Wearable_Embedded_System_Platform
2. LechJóźwiak,"Advanced mobile and wearable systems",Microprocessors and Microsystems, Volume 50, May 2017, Pages 202-221

https://www.sciencedirect.com/science/article/abs/pii/S0141933117300741#!
3. AMOL S. PATIL,UMESH J. TUPE, " Recent Trends in Platforms of Embedded Systems",International Journal of Creative Research Thoughts, VOL. 8, issue.11 https://www.ijcrt.org/papers/IJCRT2011003.pdf
4. D.T sai, W.Morley, G.J.Suaninga, N.H.Lovell, A wearable real-time image processor for a vision prosthesisComputer Methods and Programs in Biomedicine, Volume 95, Issue 3, September 2009, Pages 258-269 https://www.sciencedirect.com/science/article/abs/pii/S0169260709000923

Topics relevant to "EMPLOYABILITY": Interfacing with ARM, programming ARM with assembly and C for developing **EMPLOYBILITY SKILLS** through **PARTICIPATIVE LEARNING** Techniques. This is attained through assessment component mentioned in course handout**.**

Catalogue prepared by	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3065**	**Course Title: RFID and Flexible Sensors** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of Engineering Mathematics, Basic concepts of Engineering Physics, Knowledge of basic EM theory and sensors					
Anti-requisites	**NIL**					
Course Description	This course will introduce the concepts of RFID and Flexible Sensors. The goals of this course are 1. Gain basic knowledge of different types of materials and methods used for fabrication of flexible electronics. 2. Understand and designing Radio frequency identification (RFID) systems, middleware architectures for real-world applications. 3. Determine road map for transformation of flexible electronics from foils to textiles 4. Understand the principle and applications of flexible sensors.					
Course objective	**This course is designed to improve the learners' <u>EMPLOYABILITY SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques.**					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Have a clear understanding of the RFID technology. 2. Have a lucid picture of the material related concepts and fabrication techniques for flexible electronics 3. Know about the recent trends in wearable technology.					
Course Content:						
Module 1	Overview and RFID middleware	Assignment	Memory Recall based Quizzes	**10 *Sessions***		
Topics: Introduction- Core components of RFID systems-RFID Tags- RFID Interrogators- RFID Controllers- Frequency- selection criteria for RFID systems- Automatic identification and data, RFID Middleware- Recent focus on middleware- Core functions of RFID middleware- Middle ware as part of an RFID system-The EPC architecture- Present state of middleware development.						
Module 2	Applications of RFID technology	Assignment / Quiz	Memory Recall based Quizzes	**10 *Sessions***		
Topics: Short range RFID applications: Access control-Transportation Ticketing- Personnel identification-Vehicle identification- Production line monitoring, Long range RFID applications: Supply chain management- Mail and shipping-Clothing tags-Food production control						
Module 3	Materials for flexible electronics	Assignment	Memory Recall based Quizzes	**8 *Sessions***		
Topics: Introduction, Inorganic semiconductors and dielectrics, organic semiconductors and						

dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing of active materials.

Module 4	Principles of Sensors	Assignment	Memory Recall based Quizzes	**12 *Sessions***

Topics:
Fundamentals and Operating principles of Sensors: Types of Sensors, Use of Sensors, Basic Considerations of Sensor Design, Requirements for Accuracy, Requirements for Resolution, Environment of the Sensor, Calibration, Wireless Sensors and Wireless Sensor Networks.

Targeted Application & Tools that can be used:

This course will impart knowledge in designing a RF component or a product applying all the relevant standards and with realistic constraints at a rudimentary level.
Professionally Used Software: **COMSOL Multiphysics/MATLAB/Simulink/Labview.**

Project work/Assignment:

Assignment-1: Design and Development of Sensing RFID Tags on Flexible Foil
Assignment-2: Flexible Biopolymer based UHF RFID-Sensor for food quality monitoring

Text Books:
1. Amin Rida and Manos M. Tentzeris, RFID-Enabled Sensor Design and Applications (Artech House Integrated Microsystems), 2011, 1st edition, Artech House Publishers, UK.

Reference Books:
1. Yugang Sun, John A. Rogers, Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies), 2010, 1st Edition, William Andrew, Elsevier, USA.
2. Guozhen Shen, Zhiyong Fan, Flexible Electronics: From Materials to Devices, 2015, 1st Edition, World Scientific Publishing Co, USA

Digital references:
1. https://youtu.be/311SM_6W-LI
2. https://youtube.com/playlist?list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7
3. https://www.youtube.com/watch?v=ijqGD5FDRKw
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content
1. https://ieeexplore.ieee.org/document/6978775
2. https://ieeexplore.ieee.org/document/5733050
3. https://ieeexplore.ieee.org/document/6898713
4. https://ieeexplore.ieee.org/document/6471057
5. https://ieeexplore.ieee.org/document/7063170
6. https://ieeexplore.ieee.org/document/5251188

Topics related to development of "FOUNDATION": **Fundamentals of RFID**
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": **Basic Considerations of Sensor Design**

Catalogue prepared by	Mrs Akshatha K
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3066	**Course Title: Wireless Technologies for Wearables** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of Engineering Mathematics, Basic concepts of Wearable Technology ,Knowledge of basic EM theory and sensors					
Anti-requisites	**NIL**					
Course Description	1. Identify the need for development of wearable devices and its implications on various sectors. 2. Comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. 3. Acquaint various wearable locomotive sensors as assistive devices for tracking and navigation					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wireless Technologies for Wearables and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Identify and understand the need for development of wearable devices and its influence on various sectors. 2. Discus the applications of various wearable inertial sensors for biomedical applications. 3. Comprehend the design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. 4. Design and develop various wearable devices for detection of physiological body signals, environmental monitoring, safety and navigational assistive devices.					
Course Content:						
Module 1	Introduction to Wearable Devices	Assignment	Memory Recall based Quizzes	**10 *Sessions***		
Topics: Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors:Invasive, Non-invasive;Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.Wearable Sensors, Invisible Sensors,In-Shoe Force and Pressure Measurement; Applications Cardiac Activity, Pedometers.						
Module 2	Wireless technologies for wearable devices	Assignment / Quiz	Memory Recall based Quizzes	**10 *Sessions***		
Topics: Topics: wireless technologies for wearable: NFC, BLE, wi-fi Cellular etc. Wearable system for BAN (Body area network), system architecture, Human movement identification system, Human activity recognition system, E-health application, Assistive technology for Disabilities, sports and fitness, Augmented reality.						
Module 3	Wearable Devices for Healthcare	Assignment / Quiz	Memory Recall based Quizzes	**8 *Sessions***		
Topics: Smart textile for neurological rehabilitation system (NRS), Study of flexible and wearable EMG sensors.Epidermal electronics system (EES), Study of Multi-parametric (ECG, EEG, EMG) Epidermal						

Electronics Systems. Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Study of flexible and wearable Piezoresistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles – thermistor, infrared radiation, thermopile.

Module 4	Wearable Cameras and Microphones for Navigation	Assignment	Memory Recall based Quizzes	**12 *Sessions***

Topics:
Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist,forearmandfeet, vests and belts, head-mounted devices.

Targeted Application & Tools that can be used:

Application Area:

Wearable technology is a ubiquitous technology to monitor human beings or animals. It includes all the wearable devices, sensors in devices, communication protocols including Bluetooth, Zigbee and 3G/4G/5G, cloud computing, data fusion algorithms, and big data. The integration of all these technologies evolved an amazing technology with a huge attraction of people and within a few years, those companies who are doing their business are at the top. We are getting surrounded by wearable technology day by day. They have multiple applications in our daily life including health monitoring, education, activity monitoring, fashion, and security.

Professionally Used Software: students can use open SOURCE Softwares like Arduino IDE, Python IDLE,Jupiter etc.

Project work/Assignment:

1. **Mini Projects: At the end of the course students will be assigned a project work on solving many societal relevant problems in the field of wearables.**
2. **Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in an appropriate format.Presidency University Library Link .**
3. **Presentation: There will be a group presentation, where the students will be given a project on wearable device applications. They will have to explain/demonstrate the working and discuss the applications for the same**

Text Books:

1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.

Reference Books:

1. "Wearable Electronics Sensors - For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015.
2. "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018
3. "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies,by M. Mardonova and Y. Choi, vol. 11, p. 547, 2018.

Online Resources (e-books, notes, ppts, video lectures etc.):

56. Ambient assisted living and enhanced living environments: principles, technologies and control Ciprian Dobre, First Edition<https://www.elsevier.com/books/ambient-assisted-living-and-enhanced-living-environments/dobre/978-0-12-805195-5 >

57. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088>
58. Case studies on Wearable technology<https://www.hticiitm.org/wearables>

E-content:

8. Patel, S., Park, H., Bonato, "A review of wearable sensors and systems with application in rehabilitation"J NeuroEngineeringRehabil 9, 21 (2012). https://doi.org/10.1186/1743-0003-9-21.

9. Muhammad Mahtab Alam,"Wearable Wireless Sensor Networks: Applications, Standards and Research Trends"Jan 2015 http://dx.doi.org/10.1201/b20085-6.

10. Bujari, A. &Gaggi, Ombretta &Quadrio, Giacomo. (2018). Smart Wearable Sensors: Analysis of a Real Case Study. 10.1109/PIMRC.2018.8580729 ." *Ieee Micro*, vol. 16, no. 6 (1996),pp10-20.

11. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

Topics relevant to "EMPLOYABILITY": Wearable Devices for Healthcare, Wearable Cameras and Microphones for Navigation for developing **EMPLOYBILITY SKILLS** through **PARTICIPATIVE LEARNING** Techniques. This is attained through assessment component mentioned in course handout**.**

Catalogue prepared by	Dr.M.S Divya Rani Dr. Sumantra Chaudhuri
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3067**	**Course Title: Wearable Internet of Thing** **Type of Course: Discipline Elective** **Discipline Elective- AI and Wearable Technologies Basket**	**L – T-P-C**	**3**	**0**	**0**	**3**
Version No.	**2.0**					
Course Pre-requisites	Micro Controller Applications					
Anti-requisites	Nil					
Course Description	The purpose of this course is to enable the students to appreciate the fundamentals ofWearable technology. This field has been experiencing explosive growth with exciting applications in the fields of medicine, sports, fitness, entertainment, as well as new ways for people to interact, communicate, and experience the environment around them. Internet of Things (IoT) works with sensors and software in wearable technologies to provide a communications network that allows data collection and information exchange for wearable devices.In this course, we review aspects of wearable technologies, including the software, architecture, UX design, communication networks, and data analytics. We review current and proposed uses of this emerging technology.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wearable Internet of Thing and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Design IoT end points for wearable applications. 2) Identify the suitable materials and its processing for the development of thin film electronics. 3) Analyze the appropriate protocols, wireless techniques for the problem. **4)** Develop algorithms for wearable system and modeling of wearable system.					
Course Content:						
Module 1	**Wearable devices andRole of IoT in wearable devices**	Quizzes	Memory Recall	**14 Sessions**		
Topics: Fundamentals of Wearable Technologies- Role of Wearables, attributes of wearables, Textiles and Clothing. Flexible Electronics and Textiles for Wearable Technologies- fibers to textile sensors, interlaced network, textile sensors for physiological state monitoring, non-invasive sweat monitoring by textile sensors, smart fabrics and interactive textile platforms for remote monitoring. Smart connectivity and Big picture of IoT-smart devices, networks, Wireless technologies and need for data analysis. Evolution of wearable technology, Wearable IoT use cases- Smart watches , Android wear, Smart glasses, fitness trackers, health care devices, cameras, smart clothing etc.						
Module 2	**Materials and Novel patterning methods for flexible electronics**	Assignment / Quizzes	Programming and Simulation task	**7 Sessions**		
Topics: Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.						

Module 3	**IOT architecture and Application Development:**	Assignment	Programming and Simulation task	**12 Sessions**
Topics: IoT functional requirements, building blocks, IoT architecture layers, cloud and fog based architecture, M2M – Machine-to-Machine architecture, Web of Things, physical layer, MAC layer, 6LoWPAN security aspects in IoT. Application Protocols: MQTT, REST/HTTP, CoAP, MySQL Back-end Application Designing: Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS &jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools.				
Module 4	**Algorithms and system modeling**	Assignment	System Design Task and Analysis	**10 Sessions**
Topics: Wearable Algorithms-Data Mining for Body Sensor Network, Physical Activity Modeling and Behavior Change.				
Targeted Application & Tools that can be used **Smartphones and smart devices have emerged and penetrated deep into our everyday life. Wearables market has registered a tremendous rise in past years. Smart watches, wristbands, health monitors, and other solutions are projected to soar in the future. The goal is to increased productivityenhanced speed superior task accuracyoutstanding wireless readabilityincreased worker awareness using wearables.** Professionally Used Software:PyCharm IDE, Jupyter Notebook, Keras, Android Studio, Xcode, Tizen SDK etc.				
Project work/Assignment:				
1. Project Assignment: Development of IoT enabled - Smart watch, Cameras, Fitness meter etc. 2. Assignment 1: Interface Arduino to Zigbee module. 3. Assignment 2: Interface LED and Temperature sensor to Raspberry pi. 4. Assignment 3: Interface stepper motor to Raspberry pi. **5.** Assignment 4: Interface camera to Raspberry pi.				
Text Book(s):				
1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2013. **2.** Edward Sazonov, Michael R. Neuman (editors), Wearable Sensors: Fundamentals, Implementation and Applications, 2014, Academic Press/Elsevier, ISBN 978-0124186620				
References				

1) The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World 1st Edition
2) Jan Holler, VlasiosTsiatsis, Catherine Mulligan, StamatisKarnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.
3) Internet of Things – Architecture – Final Architectural Reference Model for the IoT v3.0, http://www.iot-a.eu/public.
4) Honbo Zhou, Internet of Things in the Cloud – A Middleware Perspective, 2012, CRC Press, ISBN 978-1439892992

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://www.coursera.org/lecture/rapid-prototyping-embedded-interface/designing-wearables-50G1E
2. https://www.coursera.org/specializations/iot
3. Introduction to Wearable Technology - Introduction to Wearable Technology | Coursera
4. Wearable Technology - A Complete Primer on Wearables | Udemy
5. https://presiuniv.knimbus.com/user#/home

E-content:

1. Nishank Jain; Alka Chaudhary; Nidhi Sindhwani; Ajay Rana-Applications of Wearable devices in IoT, 10.1109/ICRITO51393.2021.9596404. https://ieeexplore.ieee.org/document/9596404.

2. Rajendra Singh Bisht; Sourabh Jain; Naveen Tewari-"Study of Wearable IoT devices in 2021: Analysis & Future Prospects".https://ieeexplore.ieee.org/document/9445334.

3. Charles E. Bauer; Herbert J. Neuhaus- IoT & wearable electronics revolutionize electronics manufacturing paradigms httpps://ieeexplore.ieee.org/document/7939381.

4. Simone Cirani; Marco Picone - Wearable Computing for the Internet of Things https://ieeexplore.ieee.org/document/7272715.

5. Dan-Marius Dobrea; Monica-Claudia Dobrea- Concepts and developments of an wearable system - an IoT approach https://ieeexplore.ieee.org/document/8034922

Topics relevant to "EMPLOYABILITY": Coding in python for various applications of wearables. Building a wearable system for real time applications for developing **EMPLOYBILITY SKILLS** through **PARTICIPATIVE LEARNING** Techniques. This is attained through assessment component mentioned in course handout**.**

Catalogue prepared by	Mr. Syed Abrar Ahmed
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3068	**Course Title: Embedded Intelligence in WIoT** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of computer science and embedded boards					
Anti-requisites	NIL					
Course Description	The course enables student to understand the basics of how hardware chips like microcontrollers, ARM or any programmable hardware board can be used for Internet of things and protocols. Introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. To understand the concepts of Web of Things.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Embedded Intelligence in WIoT and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Understand with various concept of the IoT and their technologies. 2) Explain the real time embedded system and its components like sensors and actuators 3) To develop skillset to implement IoT systems for wearable applications by understanding the communication protocols. 4) Apply skills to conduct interfacing of embedded boards with components, actuators and sensors.					
Course Content:						
Module 1	**Fundamentals of IoT**	Quiz	Memory Recall based Quizzes	**9session**		
Topics: Introduction to Internet of Things (IoT)– Functional Characteristics – Recent Trends in the Adoption of IoT – Societal Benefits of IoT, Health Care –– Machine to Machine (M2M) - Smart Transportation – Smart Living – Smart Cities- Smart Grid.						
Module 2	**IoT Architecture**	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**10 session**		
Topics: Functional Requirements - Components of IoT: Sensors – Actuators – Embedded Computation Units – Communication Interfaces – Software Development						
Module 3	**COMMUNICATION PRINCIPALS**	Assignment	Programming Assignment	**10session**		
Topics: RFID – ZigBEE – Bluetooth – Internet Communication- IP Addresses - MAC Addresses - TCP and UDP – IEEE 802 Family of Protocols – Cellular-Introduction to EtherCAT						
Module 4	**Cloud Security basics**	Assignment	Assignment	**12 session**		
Topics: What is cloud? ,Services provided by cloud are categorized :Software As a Service(SaaS) ,Infrastructure As a Service(IaaS) ,Platform As a Service(PaaS) ,Desktop As a Service (DaaS) and VDI etc. How Cloud Computing Works, Advantages & Disadvantages,						

Applications for Businesses Cloud Service.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: embedded system design, Instrumentation and Process Control, Consumer Electronics Light sensing & controlling devices, Temperature sensing and controlling devices.

Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox

Project Work/Assignment:

Article review: At the end of coursean article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.**Presidency University Library Link .**

Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Project Assignment:- Implementation of various concepts in from deep learning using Python/ MATLAB/ SCILAB

Text Book(s):

34. Fundamentals of IoT and Wearable Technology Design : Haider Raad , Wiley
35. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research andInnovation to Market

Reference(s):

Reference Book(s):

1. .N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The EvolvingWorld of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications ,2016.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Free online self-paced course :-Introduction to IoT and Embedded systems - https://www.coursera.org/learn/iot
2. Online notes :- https://www.epcgroup.net/embedded-intelligence/
3. NPTEL online video content:-https://nptel.ac.in/courses/106/105/106105166/
4. Online ppts :- https://www.slideshare.net/jaswindersinghthind/a-basic-ppt-on-internet-of-thingsiot
5. Online ppts:-https://www.edureka.co/blog/iot-tutorial/
6. https://presiuniv.knimbus.com/user#/home

E-content:

1. Kah Phooi Seng, Li-Minn AngEmbedded Intelligence :State of art and research challenges,IEEE ACCESS, VOL. 10 pages : 59236-59258 https://ieeexplore.ieee.org/abstract/document/9775683
2. Y.-L. Lee, P.-K. Tsung and M. Wu, "Techology trend of edge AI", *Proc. Int. Symp. VLSI Design Autom. Test (VLSI-DAT)*, pp. 1-2, Apr. 2018.https://ieeexplore.ieee.org/document/8373244
3. H. Flores, P. Nurmi and P. Hui, "AI on the move: From on-device to on-multi-device", *Proc. IEEE Int. Conf. Pervasive Comput. Commun. Workshops (PerCom Workshops)*, pp. 310-315, Mar. 2019. https://ieeexplore.ieee.org/document/8730873
4. *Q. Shang, L. Chen, J. Cui and Y. Lu, "Hardware evolution based on improved simulated annealing algorithm in cyclone V FPSoCs",* IEEE Access*, vol. 8, pp. 64770-64782, 2020*. https://ieeexplore.ieee.org/document/9054951

Topics relevant to "EMPLOYABILITY": Cloud computing concepts for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Mrs Anupama Sindgi
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3069	**Course Title:** Flexible Electronics And Sensors **Type of Course:** Discipline Elective- AI and Wearable Technologies Basket	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Measuring Instruments and Sensors.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to provide an overview of flexible electronics technology and issues related material processing for thin film electronics.This course exposes the students for the materials selection and patterning methods for thin film electronics development.This course describes the process involved in transferring the flexible electronics from foils to textiles and also the challenges, opportunities and the future of wearable devices. It exposes the students to the design, challenges of wearable sensors employed for sensing the physical and biological parameters. A review on the process involved in the conversion of conducting and semiconducting fibers to smart textiles.					
CourseObjective	The objective of the course is to familiarize the learners with the concepts of Flexible Electronics And Sensors and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Realize the technology developments in the flexible electronics technology. 2. Ability to identify the suitable materials and its processing for the development of thin film electronics 3. Ability to design the pattern and develop with suitable patterning methods. 4. Realize the process involved in the transformation of electronics from foils to textiles					
Course Content:						
Module 1	**Overview of flexible electronics technology**	Case study	flexible electronics technology	**10session**		
History of flexible electronics - Materials for flexible electronics: degrees of flexiblility, substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to Roll processing - Additive printing.						
Module 2	**Amorphous and nano-crystalline silicon materials and Thin film transistors and** Wearable haptics	Case study	World of wearables	**10session**		
Topics: Fundamental issues for low temperature processing - low temperature amorphous and nanocrystalline silicon - characteristics of low temperature dielectric thin film deposition - low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability. World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunities - Future of wearables - Need for wearable haptic devices - Categories of wearable haptic and tactile display.						

Module 3	**Materials and Novel patterning methods for flexible electronics**	Case study	Print processing	**12 session**
Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.				
Module 4	**Flexible electronics sensors**	Case study	Jet Printing	**12session**
Ink-jet printing, gravure, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning, design rule considerations. Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip, and flexible solar panels				

Targeted Application & Tools that can be used:

Project Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment:-Printed electronics has the potential to revolutionize many industries. Some of the most interesting possibilities are in the areas of textiles and clothing.With electronics printed onto a substrate that is then applied to fabrics, we can add sensors, displays or other elements to existing clothing designs, or create entirely new items that take advantage of added features. Do survey on wearable sensors for monitoring patient health care system.

Text Book(s):

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, "Sensor Technologies: Healthcare, Wellness and Environmental Applications", 201, 1st Edition ,Apress Media LLC, New York.
2. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.

Reference(s):

1. Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, 1st Edition, Academic Press, Cambridge.
2. Kate Hartman, "Make: Wearable Electronics: Design, prototype, and wear your own interactive garments", 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. Yugang Sun, John A. Rogers, "Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies)", 2011, 1st Edition, William Andrew, New York.

Online and Web resource (s):

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.coursera.org/learn/freeform-electronics
3. .https://presiuniv.knimbus.com/user#/home

E-Content:

1. :Mario Caironi,Yong-Young Noh"Latest Advances in Substrates for Flexible Electronicsin Journal of the Society for Information Display, First published: 16 January 2015, https://doi.org/10.1002/9783527679973.ch10.
2. Panpan Wang,Mengmeng Hu,Hua Wang,Zhe Chen,Yuping Feng,Jiaqi Wang,Wei Ling,Yan Huanga "The Evolution of Flexible Electronics: From Nature, Beyond Nature, and To Nature"inFirst Advanced Sciences published: 28 August 2020https://doi.org/10.1002/advs.202001116https://onlinelibrary.wiley.com/doi/full

/10.1002/advs.202001116 Marc Aliqué,Claudia Delgado Simão,Gonzalo Murillo,Ana Moya"Fully-Printed Piezoelectric Devices for Flexible Electronics Applications" in Advanced Materials TechnogoliesFirst published: 25 January 2021. https://doi.org/10.1002/admt.202001020.	
Topics relevant to "EMPLOYABILITY SKILLS": World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunitiesfordeveloping Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Mrs. Srilakshmi K H Dr. K Bhanu Rekha
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE3070</td><td colspan="4">Course Title: AI & Digital Health
Type of Course: Discipline Elective- AI and Wearable Technologies Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">Introduction to computer science, database management system.</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL.</td></tr>
<tr><td>Course Description</td><td colspan="9">Over the next decade artificial intelligence is likely to transform the biomedical world. Deep-learning algorithms could aid in developing new drugs, interpreting medical images, cleaning up electronic patient charts, and more. This subject explores the promise of this nascent revolution.</td></tr>
<tr><td>Course Objective</td><td colspan="9">The objective of the course is to familiarize the learners with the concepts of AI& Digital Health and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
1. Explain basic principles of AI & Digital Health.
2. Understand the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning.
3. Illustrate object-oriented concepts.
4. Develop database and GUI applications.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="3">THE BASICS OF ARTIFICIAL INTELLIGENCE</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td>10 Hours</td></tr>
<tr><td colspan="10">Artificial intelligence: a reference point for innovation, What is Artificial Intelligence?Narrow, general, or super?What do you need for developing A.I.?Data Analytics, Machine Learning & Deep Learning – Methods of Teaching Algorithms, Data in healthcare, A brief history and the current state of electronic medical records, Why do we need help from A.I. when it comes to data?Health data management, Treatment pathway design, Transforming diagnostics, Health assistance and administration, Patient management, Precision medicine, Supporting pharma: drug creation and clinical trials, FDA-approved Algorithms in Healthcare</td></tr>
<tr><td>Module 2</td><td colspan="3">APPLYING ARTIFICIAL INTELLIGENCE IN HEALTHCARE</td><td>Assignment/ Quiz</td><td colspan="3">Conceptual Descriptive</td><td>10 Hours</td></tr>
<tr><td colspan="10">Health data management, Treatment pathway design, Transforming diagnostics, Health assistance and administration, Patient management, Precision medicine, Supporting pharma: drug creation and clinical trials, FDA-approved Algorithms in Healthcare.</td></tr>
<tr><td>Module 3</td><td colspan="3">CHALLENGES OF ARTIFICIAL INTELLIGENCE</td><td>Assignment/ Quiz</td><td colspan="3">Programming & Simulation</td><td>14 Hours</td></tr>
<tr><td colspan="10">Misconceptions and overhyping, Technological limitations of A.I., Limitations of available medical data, The indispensable work of data annotators, Judgemental datasets and A.I. bias in healthcare, The need to regulate A.I., The ethics of A.I., Could you sue diagnostic algorithms or medical robots in the future?Should algorithms mimic empathy?Could A.I. Solve the Human Resources Crisis in Healthcare?</td></tr>
<tr><td>Module 4</td><td colspan="3">FUTURE OF HEALTHCARE</td><td>Assignment/ Quiz</td><td colspan="3">Conceptual Descriptive</td><td>6 Hours</td></tr>
</table>

Shifting from Volume to Value, Evidence-based medicine, Personalized medicine, Connected Medicine: Disease and condition management, virtual assistant, Remote monitoring. Accessible diagnostic Tests. Digital health and Therapeutics.

Targeted Application &Tools that can be used:

JOBS-

Earlier disease detection with ai
More accurate cancer diagnosis with ai
An intelligent symptom checkers
Ai deep learning for actionable insights
Earlier cancer detection with ai

Text Book(s):

T1: A guide to artificialIntelligence Inhealthcare, by Dr. Bertalan Meskó& Nóra Radó. The Medical FuturistPublishing, 1st edition, 2019.

T2: Artificial Intelligence in Healthcare,by MichaelMathenyNational Academy of Medicine, 1st edition, 2019.

T3:Digital Health: Truly Transformational, by Rajendra Pratap Gupta, Publisher: Wolters Kluwer India Pvt Ltd, 1st edition, 2021.

T4: Machine Learning and AI for Healthcare, by Arjun Panesar, Publisher:Apress. ISBN-13 (electronic): 978-1-4842-3799-1

Online e-learning materials

Coursera:

1. **https://www.coursera.org/learn/introduction-to-digital-health**
2. **https://ocw.mit.edu/courses/health-sciences-and-technology/hst-947-medical-artificial-intelligence-spring-2005/**
3. **https://www.mtu.edu/gradschool/programs/certificates/ai-healthcare/**

References:

R1: Artificial Intelligence in Health Care System, by Amar Shukla & Lalit Kane, Nitya Publications

R2: The Digital Health Revolution, by Kevin Pereau; Publisher :Transcendit Health

E-Content

1. Yu, Kun-Hsing, Andrew L. Beam, and Isaac S. Kohane. "Artificial intelligence in healthcare." *Nature biomedical engineering* 2, no. 10 (2018): 719-731.
2. Noorbakhsh-Sabet, Nariman, Ramin Zand, Yanfei Zhang, and Vida Abedi. "Artificial intelligence transforms the future of health care." *The American journal of medicine, Elsevier,* 132, no. 7 (2019): 795-801.
3. Ghazal, Taher M. "Internet of things with artificial intelligence for health care security." *Arabian Journal for Science and Engineering, Springer nature* (2021): 1-12.
4. Mansour, Romany Fouad, Adnen El Amraoui, Issam Nouaouri, Vicente García Díaz, Deepak Gupta, and Sachin Kumar. "Artificial intelligence and internet of things enabled disease diagnosis model for smart healthcare systems." *IEEE Access* 9 (2021): 45137-45146.

Topics relevant to "EMPLOYABILITY SKILLS": Health assistance and administration Patient management, Precision medicine, Supporting pharma: drug creation and clinical trials for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout. Patient management Precision medicine Supporting pharma: drug creation and clinical trials	
Catalogue prepared by	**Dr. Pritam Keshari Sahoo and Dr.Ashutosh Anand**
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3071**	**Course Title:Wearable and Ubiquitous Computing** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of NFC, Wireless LAN					
Anti-requisites	**NIL**					
Course Description	The goal of this course is to acquaint students with some of the fundamental concepts and state-of-the-art research in the areas of ubiquitous computing. Since this field is rapidly progressing, the course is aimed at students who want to explore it as researchers or track its evolution. The major focus of this is to course is to explore the high level facilities, system architecture and protocols of the ubiquitous system and apply data analytics to facilitate next generation computing. A significant portion of the course will cover the Internet of Things (IoT). Less emphasis will be given to the hardware and device level details.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using AI & IOT.					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe the various types of location based architectures and its application. (2) Discuss the basics of context aware architecture and its applications. (3)Explain the augmented reality of digital pen and paper. (4)Employ techniques IoT in data processing and analysis.					
Course Content:						
Module 1	Introduction to **Networking Basics and Location in ubiquitous computing:**	Quiz	Memory Recall based Quizzes		**10Sessions**	
Topics: Overview, Challenges, NFC, Wireless LAN, Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN Recommendation.						
Module 2	**Context-aware computing**	Assignment/Quiz	Theoretical Understanding		**11 Sessions**	
Topics: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture, Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing.						
Module 3	**Wearable and Mobile affective computing**	Assignment/Quiz	Theoretical Understanding		**7 Sessions**	
Topics: Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network, Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI.						
Module 4	**Introduction to**	Assignment	Theoretical		**9**	

	IoT and data analytics		Understanding	**Sessions**

Topics:
Definition, trend, IOT components, IOT Applications, Cloud centric IOT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, New Protocols, QoS, QoE, IOT and Data Management, Data cleaning and processing, Data storage, models, Search techniques.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used: Application Area is in the field of assistive robotics, Automatic machine translation, object detection etc.

Professionally Used Software: python/C,C++,Jupyter Notebook on cloud/ MATLAB.

Project work/Assignment:

1.Case Studies: At the conclusion of each module, we will have a 'case-based' discussion session for approximately half the class period. Cases will be from lecture / journal article content by considering a 'real-world' scenario where the course concepts can be applied. We will post the case one week in advance. For each case, each student from each group formed will write a 1-2-page executive summary outlining their understanding, including relevant analyses, schematics, and graphs. Guidelines on report format will be provided with the first case.**Presidency University Library Link.**
2.Book/Article review: At the end of each module, a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page.
3.Presentation: There will a group presentation on latest trends and advancements in Wearable robots**.**

Text Book(s):
1. Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010 First Edition
2. Papers from the ACM and IEEE digital libraries.

Reference(s):
1. **Jacob Rosan, "Wearable Robots", 2019, First Edition, Elsevier.**
2. https://nptel.ac.in/courses/106/103/106103220/

Online Resources (e-books, notes, ppts, video lectures etc.):
1. Lecture Series on Embedded Systems by Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT Delhi
   (315) Lecture - 37 Pervasive & Ubiquitous Computing - YouTube
2. Thad Starner reviews the greatest hits of wearable computing and describes an unusual and surprising application currently being explored at Georgia Tech, where Starner is an Associate Professor in the School of Interactive Computing.
   (315) Wearable Computing: the Next Generation of 'Borg - YouTube

E-content:

1. Context-awareness in wearable and ubiquitous computing by D Abowd, AK Dey, R Orr, J Brotherton - Virtual Reality, 1998 – Springer.
2. An architecture concept for ubiquitous computing aware wearable computers by M Bauer, B Brugge, G Klinker, computing Systems …, 2002 - ieeexplore.ieee.org
3. Overview of the Internet of Things and Ubiquitous Computing S Mehrotra, S Sinha, SK Sharma - Blockchain Technology for …, 2021 - taylorfrancis.com

Topics relevant to "EMPLOYABILITY SKILLS": Semantic Web Data Management, Searching in IOT, Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processingfordeveloping Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Ms. Swetha.G
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3072**	**Course Title:Secure Wearable Internet of Things** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**To succeed in this course the student should be comfortable with basic concepts of Wireless communication standards: Bluetooth - IEEE 802.15.1, Wireless LAN- IEEE 802.11(WiFi). The basic Fundamentals of communication, Signal Types and its characteristics, Data Transmission Types, Communication Techniques, Data Transmission Modes, Network Topologies and its applications and also Microcontroller units, Architecture, interfaces and memory architecture.**					
Anti-requisites	**NIL**					
Course Description	**The course is designed for undergraduate students to introduce the field of secure wearable IOT technology. Wearable technologies field has been experiencing explosive growth with exciting applications in the fields of medicine, sports, fitness, entertainment, as well as new ways for people to interact, communicate, and experience the environment around them. Internet of Things (IoT) works with sensors and software in wearable technologies to provide a communications network that allows data collection and information exchange for wearable devices. The applications of this exciting new field ranges from helping in managing chronic diseases to experiencing entertainment like sports and games in a virtual-reality setting.**					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Secure Wearable Internet and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Design and develop IoT end points for wearable applications. 2) Identify the real-world problem and give IoT solutions. 3) Analyse and select appropriate protocols and wireless techniques for secured IOT. 4) Summarize various implementation and roadmaps of Wearable Device Technology.					
Course Content:						
Module 1	Role of IoT in wearable devices	Assignment	Programming and simulation Task	**8 Sessions**		
Topics: Smart connectivity and Big picture of IoT-smart devices, networks, Wireless						

technologies and need for data analysis. Evolution of wearable technology, Wearable IoT use cases- Smart watches, Android wear, Smart glasses, fitness trackers, health care devices, cameras and smart clothing.				
Module 2	IoT supported technologies: Internet/Web and networking basics,Hardware platforms	Assignment	Case studies	10 Sessions
Topics: OSI model, data transfer referred with OSI model, IP Addressing, point to point data transfer, point to multi point data transfer & network topologies, sub-nets, network topologies referred with web, introduction to web servers and cloud computing. Network Fundamentals: Overview and working principle of wired and wireless networking equipment's – router, switches, access points, and hubs.				
Module 3	IOT architecture and application development	Project Assignment	Implementation	8 Sessions
Topics: IoT functional requirements, building blocks, IoT architecture layers, cloud and fog based architecture, M2M – Machine to Machine architecture, Web of Things, physical layer, MAC layer, 6LoWPAN security aspects in IoT.Application Protocols: MQTT, REST/HTTP, CoAP, MySQL Back-end Application Designing.				
Module 4	Implementations and RoadMap	Presentation		8 Sessions
Topics: Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.				
Targeted Application & Tools that can be used: Applications: Wireless Communication like 5G,LoRa Tools: Wireshark,SOASTACloudTest,Shodan/MATLAB				
Text book(s): 1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2013. 2. Edward Sazonov, Michael R. Neuman (editors), Wearable Sensors: Fundamentals, Implementation and Applications, 2014, Academic Press/Elsevier, ISBN 978-0124186620.				
Reference Book(s): **1.** Honbo Zhou, Internet of Things in the Cloud – A Middleware Perspective, 2012, CRC Press, ISBN 978-1439892992 2. Claire Rowland, Elizabeth Goodman, Martin Chalier, Ann Light, Alfred Lui, Designing Connected Products: UX for the Consumer Internet of Things, 2015, O'Reilly Media, Inc, ISBN 978-1449372569 **E-Content:** 1. IEEE Standards Association Working Group for an Architectural Framework for the Internet of Things (IoT) (P2413) - http://grouper.ieee.org/groups/2413/ 2.http://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/ 3.http://www.infosecurity-magazine.com/view/30620/tridium-vulnerability-throws-building-controls-wide-open-to-hackers/ 4. Internet of Things – Architecture – Final Architectural Reference Model for the IoT v3.0, http://www.iot-a.eu/publi				

Topics relevant to "EMPLOYABILITY SKILLS": health care, defense, home automation for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Mr.Nipun Sharma
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3073	**Course Title: Wearable Prosthetics and Robots** **Type of Course: Discipline Elective- AI and Wearable Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	**Basic concepts of mechatronics and biomechanics**						
Anti-requisites	**NIL**						
Course Description	The purpose of this course is to enable the students to understand the fundamentals of wearable robot which is a mechatronic system that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with. This course gives an overview of wearable robotics, providing the students with a complete understanding of the key applications and technologies suitable for its development. The courses develop technical thinking skills of the students and make them aware of the technology which is now employed in telemanipulation, man-amplification, neuromotor control research and rehabilitation, and to assist with impaired human motor control.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wearable Prosthetics and Robots and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING						
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe the various types of exoskeletons and its application. (2) Discuss the basis of bioinspiration and biomimetic in wearable robots (3) Explain the kinematics dynamics involved in wearable robots. (4) Employ techniques for human-robot cognitive interaction.						
Course Content:							
Module 1	Introduction to Wearable Robots	Quiz	Memory Recall based Quizzes	**10Sessions**			
Topics: Wearable robots and exoskeletons, role of bio inspiration and bio mechatronics in wearable robots, Technologies involved in robotic exoskeletons,A classification of wearable exoskeletons: application domains.							
Module 2	Basis for bioinspiration and biomimetic in wearablerobots	Assignment/Quiz	Theoretical Understanding	**9 Sessions**			
Topics: Introduction; General principles in biological design: Optimization of objective functions-energy consumption, Multifunctionality and adaptability, Evolution; Development of biologically inspired design: Biological models, Neuromotor control structures and mechanisms as models, Muscular physiology as a model, Sensorimotor mechanisms as a model, Biomechanics of human limbs as a model.							

Module 3	Kinematics and dynamics of wearable robots	Assignment/Quiz	Theoretical Understanding	**7 Sessions**
Topics: Introduction; Robot mechanics-motion equations: Kinematics analysis, Dynamic analysis; Human biomechanics: Medical description of human movements: Arm Kinematics, Leg kinematics, Kinematic models of the limbs, Dynamic modelling of the human limbs; Kinematics redundancy in exoskeleton systems: Introduction to kinematic redundancies, Redundancies in human-exoskeleton systems.				
Module 4	Human–robot cognitive interaction	Assignment	Theoretical Understanding	**9 Sessions**
Topics: Introduction to human–robot interaction; cHRI using bioelectrical monitoring of brain activity; Physiology of brain activity; Electroencephalography (EEG) models and parameters; Brain-controlled interfaces: approaches and algorithms; cHRI through bioelectrical monitoring of muscle activity (EMG); Physiology of muscle activity; Electromyography models and parameters; Surface EMG signal feature extraction; Classification of EMG activity; Force and torque estimation;cHRI through biomechanical monitoring ; Biomechanical models and parameters; Biomechanically controlled interfaces: approaches and algorithms.				
Targeted Application & Tools that can be used: Application Area is in the field of assistive robotics **Professionally Used Software: python/C,C++**				
Text Book(s): 1. Pons, José L. Wearable robots: bio mechatronic exoskeletons, John Wiley & Sons, 2008				
Reference(s): 1. Winter, David A. Biomechanics and motor control of human movement . John Wiley &Sons, 2009 2. Jacob Rosan, "Wearable Robots", 2019, First EditionWearable Robots",, Elsevier **Online Resources (e-books, notes, ppts, video lectures etc.):** **1. https://nptel.ac.in/courses/112/107/112107289/** **2. https://nptel.ac.in/courses/112/105/112105249/** **3.** (315) 06: Wearable Robotic Technologies - Chapter 3 - Exoskeletons (Part 2) - YouTube **E-content:** 1. Simulation of Stand-to-Sit Biomechanics for ***Robotic*** Exoskeletons and ***Prostheses*** with Energy Regeneration. IEEE Transactions on Medical ***Robotics*** 2.Benchmarking Wearable Robots: Challenges and ... – Frontiers-https://www.frontiersin.org › frobt.2020.561774 › full by D Torricelli · 2020 3.Human-Centered Design of Wearable Neuroprostheses-https://ojs.aaai.org › aimagazine › article › by JL Contreras-Vidal · 2015.				
Topics relevant to "EMPLOYABILITY SKILLS": Electromyography models and parameters; Surface EMG signal feature extraction; Classification of EMG activity; Force and torque estimation for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout				
Catalogue prepared by	Ms.Swetha.G			
Recommended	BOS Meeting NO: 19th BOS held on 06/07/2024			

by the Board of Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3074	**Course Title:Applications of Brain Computer Interfaces** **Type of Course: Discipline Elective-AI and Wearable Technologies Basket**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts and techniques for processing of discrete-time signals, systems and transforms. Understanding of FIR and IIR Filters; Discrete Fourier Transform (DFT) and Fast Fourier transform (FFT) techniques and their applications; Implementation of DSP algorithms on DSP processors.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to provide the students with an understanding of the origin and nature of brain signals. This conceptual and analytical course teaches students how to use EEG signals to examine people's mental health condition using signal processing techniques. As part of the course's critical thinking component, students may gather EEG data in order to create BCI interfaces for a particular group of cognitive impairments and rehabilitation. The course's thoroughness includes a variety of examinations and signal processing projects using a variety of tools to improve students' capacity to work independently as BCI designers.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Applications of Brain Computer Interfaces and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of this course the students shall be able to: (i) **Explain** the origin and characteristics of brain signals such as EEG. (ii) **Apply**hardware and software based techniques for designing BCI systems. (iii)**Demonstrate**the abilities of various machine learning methods for Brain Signal analysis and interpretation. (iv)**Illustrate** the working and operating principlesexisting and future BCI Interfaces.					
Course Content:						
Module 1	**The Human Brain and EEG Signal**	Quiz	Memory Recall based Quizzes	**15Classes**		
Human brain - various parts, reference points, neuronal activity in motor cortex and related areas; Direct pathway of movement; EEG - Signal and its types, Electrodes, Acquisition, Rhythms; Artifacts - Spatial Filtering, Event-Related Potential (ERP), Movement-Related (Cortical) Potentials (MRPs/MRCPs), ERD/ERS, Steady-State Visual Evoked Potentials (SSVEPs).						
Module 2	**BCI Design and Implementation**	Assignment / Quiz	Programming and Simulation task	**15 Classes**		

Brain Signal Acquisition – within and outside; Feature extraction and translation; BCI Hardware and Software; BCI Operation and Protocols; BCI Applications.				
Module 3	**BCI Machine Learning**	Assignment	Memory Interfacing Task and Analysis	**12 Classes**
Linear Classifiers – LDA, SVM; Artificial Neural Network Classifiers – MLP, Deep Neural Nets and other classifiers; Hidden Markov Models (HMMs); Advance Topics.				
Module 4	**Existing and Future BCI Interfaces**	Assignment	System Design Task and Analysis	**08 Classes**
P300-Based BCI; SSVEP-Based BCI; ERD/ERS-Based BCI; BCIs for medicine and rehabilitation; Advance Topics				

Targeted Application & Tools that can be used:

Application Area is in EEG Signal Processing applications leading to design of medical devices and BCI systems.

Professionally Used Software: Matlab / Python / LabVIEW

Textbook(s):

1. Nam, Chang S., Anton Nijholt, and Fabien Lotte, eds. Brain–computer interfaces handbook: technological and theoretical advances. CRC Press, 2018.
2. Wolpaw, Jonathan R. "Brain–computer interfaces." In Handbook of Clinical Neurology, vol. 110, pp. 67-74. Elsevier, 2013.

Reference Book(s):

1. Bastos-Filho, Teodiano Freire, ed. Introduction to Non-Invasive EEG-Based Brain-Computer Interfaces for Assistive Technologies. CRC Press, 2020.
2. Ramsey, Nick F., and José del R. Millán. Brain-Computer Interfaces. Elsevier, 2020.
3. Dornhege, Guido, José del R. Millán, Thilo Hinterberger, Dennis J. McFarland, and Klaus-robert Muller. Toward brain-computer interfacing. Vol. 63. Cambridge, MA: MIT press, 2007.
4. Reddy D. C., "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005.

Online Resources (e-books, notes, ppts, video lectures etc.):

55. Prof. Mahesh Jayachandra's NPTEL Lecture Notes and Videos on Introductory Neuroscience & Neuro-Instrumentation (IISc Bangalore): https://nptel.ac.in/courses/108108167
56. Prof. Vikas V's NPTEL Lecture Notes and Videos on Neural Science for Engineers (National Institute of Mental Health and Neurosciences, NIMHANS): https://onlinecourses.nptel.ac.in/noc22_ee66/preview
57. MIT Open Course Ware Lecture Notes on "Biomedical Signal and Image Processing". https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/pages/lecture-notes/"
58. Introduction to Modern Brain-Computer Interface Design - Christian A. Kothe Swartz Center for Computational Neuroscience, University of California San Diego: https://www.youtube.com/watch?v=PWRGe3uyS4c
59. Brain Computer Interface w/ Python and OpenBCI for EEG data:https://www.youtube.com/watch?v=Dgo7F-lpyYE
60. Dr. Kunal Pal's Video lectures on "Biomedical Signal Processing" from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8

E-content:

59. Wolpaw, Jonathan R., Niels Birbaumer, Dennis J. McFarland, GertPfurtscheller, and Theresa M. Vaughan. "Brain–computer interfaces for communication and control." Clinical neurophysiology 113, no. 6 (2002): 767-791. https://classes.engineering.wustl.edu/ese497/images/b/b3/2002Wolpaw_Review.pdf
60. Moore, Melody M. "Real-world applications for brain-computer interface technology." IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol.11, no. 2 (2003), pp. 162-165. https://www.cs.cmu.edu/~tanja/BCI/RealWorldAppl2003.pdf
61. Shih, Jerry J., Dean J. Krusienski, and Jonathan R. Wolpaw. "Brain-computer interfaces in medicine." In Mayo clinic proceedings, vol. 87, no. 3, pp. 268-279. Elsevier, 2012. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3497935/pdf/main.pdf
62. Van Erp, Jan, Fabien Lotte, and Michael Tangermann. "Brain-computer interfaces: beyond medical applications." Computer 45, no. 4 (2012): 26-34. https://ieeexplore.ieee.org/document/6165246
63. Gu, Xiaotong, Zehong Cao, AlirezaJolfaei, Peng Xu, Dongrui Wu, Tzyy-Ping Jung, and Chin-Teng Lin. "EEG-based brain-computer interfaces (BCIs): A survey of recent studies on signal sensing technologies and computational intelligence approaches and their applications." IEEE/ACM transactions on computational biology and bioinformatics 18, no. 5 (2021): 1645-1666. https://ieeexplore.ieee.org/document/9328561

Topics relevant to "EMPLOYABILITY SKILLS": Analysis of EEG and other cognitive disorder monitoring related signals for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout..

Catalogue prepared by	Ms.Natya.S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

IOT and Sensor Technologies Basket

Course Code: **ECE3075**	**Course Title: IoT: Architecture and Protocols** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	NIL					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to introduce the students to the Internet of Things (IoT) technologies and Industry 4.0 which is transforming the industry by integrating modern technology with the help of sensors, computational processes and communication technologies. The course inculcates critical thinking skill within students to develop and design a complete solution using program and interfacing hardware to provide wireless or wired smart solutions. The nature of course being comprehensive as well as application based, covers number of quizzes, simulations and interfacing practical's which helps to enhance students' abilities to become an IoT Application Designer					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	**On successful completion of this course the students shall be able to:** x) Discuss the various types of IoT architectures. xi) Explore various cloud based architecture. xii) Discuss various types of communication protocol used in IoT applications. xiii) Design an IoT based application.					
Course Content:						
Module 1	**IoT Architecture & components**	Assignment/ Quiz	Memory Recall based Quizzes	**12 Sessions**		
Topics: Basics of IoT, Design and Components, future of the technology, scope and Challenges, IoT enabled Areas, characteristics, Market research for the technology, Sensors and actuators, M2M IoT standard Architecture, IoT world forum (IoTWF) standardized architecture. Architecture (2 ,3 Layer) , Physical device and control layer, Connectivity layer, edge computing layer, Upper layers, IoT reference Model . simplified IoT architecture-A core of IoT functional Stack						
Module 2	**Data management**	Assignment/ Quiz	Real time Application Project	**12 Sessions**		
Topics: Selection of IoT Platform, Embedded System, data management and computing stack-Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud, AWS						
Module 3	**Communication in IoT**	Assignment/ Quiz	Memory Recall based Quiz	**11 Sessions**		
Iot Accessing technology- IEEE 802.15.1, networking layers, physical layer and topology. IPV4 and IPV6 Addressing IoT nodes, IoT Edge, 6LOWPAN, MQTT, AMQP, COAP and MDNS,						

Web socket Application aware communication, Network and channel aware communication – Topologies and Hierarchy, IoT LAN and WAN connectivity RFID, BLE,LPWAN , LORA .Real time application of IoT.

List of Laboratory Tasks:
NIL

Targeted Application & Tools that can be used:

Important Applications range from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IOT
Professionally Used Software: Kiel, C and Python, Arduino boards and Raspber-iPi

Project Work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.Presidency University Library Link .
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
4. Assignment:Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples.
Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate.
Assignment: 2] Design a IOT based application for

a. Health care
b. Agriculture
c. Transport Management
1 Stock Management
e. COVID-19

Text Book(s):

1. Sudip Misra, , Anandarup Mukherjee, Arijit Roy " Introduction to IOT ", Cambridge University Press, January 2021

Reference(s):
Reference Book(s):

R1 Arshdeep Bagha & Vijay Madisetti, " Internet of Things a Hands on Approach"

R2 Adrian McEwen & Hakim Cassimally "Designing the Internet of Things"

R3 IoT Fundamentals□□Networking Technologies, Protocols, and Use Cases for the Internet of Things By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

Online Resources (e-books, notes, ppts, video lectures etc.):

1.. https://nptel.ac.in/courses/117/103/117103063/
2 .https://nptel.ac.in/courses/108108179

E-Content:-

1 Cheena Sharma and Naveen Kumar Gondhi 2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU) 23-24 Feb. 2018Communication Protocol Stack for Constrained IoT Systems. https://ieeexplore.ieee.org/document/8519904/authors#authors

2 Bertha Mazon-Olivo and Alberto Pan IEEE Latin America Transactions 1 Jan.-

2022 Internet of Things: State-of-the-art, Computing Paradigms and Reference Architectures.
https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9662165

3. Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.https://ieeexplore.ieee.org/document/8439638

1. Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International Conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.
https://ieeexplore.ieee.org/document/8439638

Topics relevant to the: "FOUNDATION SKILLS", Introduction and background on IoT Technology, Introduction to IOT Technology, Cloud Computing
Topics relevant to the:" EMPLOYABILITY", Industry 4.0 and IoT.

Catalogue prepared by	Mrs. Renuka Bhagwat
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3076**	**Course Title:** **IoT Platforms and Application Development** **Type of Course:Discipline Elective- IOT and Sensor Technologies Basket**		**L-T- P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basic conceptual understanding of electric circuits with sensors to connect to IoT components. Familiarity with these networking protocols and web development concepts is highly recommended.						
Anti-requisites	NIL						
Course Description	This course on Internet of Things (IoT), is meant for any engineering undergraduate / graduate to acquire fundamental knowledge about the what, why, and how of IoT. It teaches you from the very basic building blocks of IoT, their relationship, and expands the details of developing these building blocks and making some end-to-end applications using IoT.						
Course Objective	This course is designed to improve the learners " EMPLOYABILITY SKILLS" by using PARTICIPATIVE LEARNING techniques using "THINKSPEAK" (Known as the cloud IoT platform with MATLAB analytics)						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Explain the need and requirement for IoT Protocols. 2. List the most popular platforms on which IoT is employed. 3. Identify the networking requirements for a given IoT application. 4. Implement a given IoT scenario on a simulation platform.						
Course Content:							
Module 1	Introduction to IoT platform	Assignment/ Quiz	Memory Recall based Quizzes	**12 Hours**			
Background of IoT. Overview of IoT platforms: Platforms Supporting Network Servicing, Platforms Sitting Between Networks and Applications, Application-Layer Development Platforms. Listing the functionalities and capabilities of good IoT Platform. Building Blocks of an IoT Solution. Functional Blocks of an IoT Solution.							
Module 2	Essential requirement for Building IoT Platform	Assignment/ Quiz	Memory Recall based Quizzes	**12 Hours**			
Deciding Cloud Instance Specifics, Expanding on the IoT Platform Block Diagram: Edge Interface, Message Broker, and Message Bus, Message Router and Communications Management, Time-Series Storage and Data Management, REST API Interface, Microservices, Rule Engine, Device Manager and Application Manager.							
Module 3	Connecting with the Platform in Real Time	Assignment/ Quiz	Memory Recall based Quizzes	**11 Hours**			
Using MQTT as the Message Broker, Data Storage Schema, Accessing Platform Resources Through APIs, Data Accessing APIs, Elementary Microservices and Utilities, Routing and Filtering Data and Messages,							
Module 4	Block-level architecture of IoT platform	Assignment/ Quiz	Memory Recall based Quizzes	**10 Hours**			
Initializing the Cloud Instance, Installing Basic Software Stacks, Securing the Instance and							

Software, Installing Node.js and Node-RED.

Targeted Application & Tools that can be used:

JOBS-

- Collecting data using IoT devices as a data analyst.
- Designing PCB's like an embedded programs engineer.
- Setting up sensors and actuators as a professional in the field to meet application and design specifications.
- Leveraging customer understanding through user interface roles that define specifications and specialisations.
- Working with hardware and devices through integration.
- Working in security to face the internet's core problems and safeguard users and applications from malicious attacks.
- Deploying solutions as a network and networking structure expert.

TOOLS – MATLAB, Embedded-C/C++ and Python.

Project work/Assignment:

1.Case Study- Industry 4.0 Platform Helps Advance Smart Manufacturing Operations:

A leading global tool manufacturing company with multiple lines of business and more than 100 factories worldwide lacked visibility into production metrics, such as overall equipment effectiveness (OEE). With machines varying in age and complexity, and two fundamentally different types of facilities, few assets were instrumented with sensors that provided data analytics to management. The objective was to create significant value—in the hundreds of millions—in the next five years as it moves from a focus on efficiency improvements to an Industry 4.0 platform that promotes connectivity and digital visualization.
https://www.cognizant.com/us/en/case-studies/industrial-iot-platform

2. Book/Article review:

At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.

3. Presentation:

There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment:

With cities and urban areas getting crowded by the minute, finding a parking space is nothing short of a challenge. It is not only time-consuming but also quite frustrating. For solving the parking problem crisis, develop IoT-based smart parking system to avoid unnecessary travelling and harassment in the search for an appropriate parking area.

Assignment1: If you are at a parking space, the developed model should use an IR sensor to monitor the entire area during the run time and provide you an image for the same. This allows you to see any free spaces in the parking lot and drive straight to it without wasting any time in looking for a parking space. **Assignment2:** The developed model should tun ON to open the car gate only if there are empty slots available in a parking space.

Text Book(s):

T1: David Etter, "IoT (Internet of Things) Programming: A Simple and Fast Way of Learning IoT," Kindle Edition. 2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, and David Boyle, "From Machine to Machine to the Internet of Things:

T2: Anand Tamboli "Build Your Own IoT Platform", Apress

References:

R1: Introduction to a New Age of Intelligence," Elsevier Science Publishing Co. Inc, 2014.
R2: Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," 1st Edition, Auerbach Publications, 2017.
R3: Yasuura, H., Kyung C.M., Liu Y., and Lin Y.L., "Smart Sensors at the IoT Frontier," 1 st Edition, Springer International Publishing, 2018.

Online Resources (e-books, notes, ppts, video lectures etc.)

1. NPTEL/ Coursera/Udemy Courses link:

(i) **NPTEL: https://nptel.ac.in/courses/106/105/106105166/**
(ii) **Coursera:**
a. **https://www.coursera.org/learn/cloud-iot-platform**
b. **https://www.coursera.org/specializations/iot**
(iii) **Udemy: https://www.udemy.com/course/introduction-to-edge-computing/**

E-content

(i) D. -H. Park, H. -C. Bang, C. S. Pyo and S. -J. Kang, "Semantic open IoT service platform technology," 2014 IEEE World Forum on Internet of Things (WF-IoT), 2014, pp. 85-88, doi: 10.1109/WF-IoT.2014.6803125.
https://ieeexplore.ieee.org/document/6803125

4. M. A. López Peña and I. Muñoz Fernández, "SAT-IoT: An Architectural Model for a High-Performance Fog/Edge/Cloud IoT Platform," 2019 IEEE 5th World Forum on Internet of Things (WF-IoT), 2019, pp. 633-638, doi: 10.1109/WF-IoT.2019.8767282.
https://ieeexplore.ieee.org/document/8767282

5. J. -H. Park, S. -C. Choi, I. -Y. Ahn and J. Kim, "Multiple UAVs-based Surveillance and Reconnaissance System Utilizing IoT Platform," 2019 International Conference on Electronics, Information, and Communication (ICEIC), 2019, pp. 1-3, doi: 10.23919/ELINFOCOM.2019.8706406.
https://ieeexplore.ieee.org/document/8706406

Tutorial

Develop and deploy a Node.js IoT Edge module using Linux containers
https://docs.microsoft.com/en-us/azure/iot-edge/tutorial-node-module?view=iotedge-2020-11

Topics relevant to "EMPLOYABILITY SKILLS": Using MQTT as the Message Broker, Data Storage Schema for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout..

Catalogue prepared by	Ms. Natya.S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3077	**Course Title:Wireless Protocols for IOT Type of Course Discipline Elective-IOT and Sensor Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of Networking, Application design, Application Development, Security and Artificial Intelligence					
Anti-requisites	**NIL**					
Course Description	This course will enable students to understand various sources of IoT & M2M communication protocols. It also describes Cloud computing and design principles of IoT. Students become aware of MQTT clients, MQTT server and its programming along with understanding the architecture and design principles of WSNs which enrich the knowledge about MAC and routing protocols in WSNs.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wireless Protocols for IOT and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1) **Summarize** the OSI Model for the IoT/M2M Systems. 2) **Demonstrate** the architecture and design principles for IoT. 3) **Develop** the programming concepts for IoT Applications. 4) **Identify** the communication protocols which best suits the WSNs.					
Course Content:						
Module 1	Overview of Internet of Things	Quiz	Memory Recall based Quizzes	**11session**		
Topics:**Overview of Internet of Things**: IoT Conceptual Framework, IoT Architectural View, Technology Behind IoT, Sources of IoT,M2M communication, Examples of IoT. Modified OSI Model for the IoT/M2M Systems, data enrichment, data consolidation and device management at IoT/M2M Gateway, web communication protocols used by connected IoT/M2M devices, Message communication protocols (CoAP-SMS, CoAP-MQ, MQTT,XMPP) for IoT/M2M devices.						
Module 2	Architecture and Design Principles for IoT	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**12 session**		
Topics: **Architecture and Design Principles for IoT**: Internet connectivity, Internet-based communication, IPv4, IPv6,6LoWPAN protocol, IP Addressing in the IoT, Application layer protocols: HTTP, HTTPS,FTP,TELNET and ports. **Data Collection, Storage and Computing using a Cloud Platform**: Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud- based data collection, storage and computing services using Nimbits.						
Module 3	Overview of Wireless Sensor Networks	Assignment	Programming Assignment	**17 session**		
Topics: **Overview of Wireless Sensor Networks**: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. **Architectures:** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture-Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts.						
Module 4	Wireless Protocols	Assignment	Programming	**17**		

	for IoT		Assignment	**session**

Topics:
Wireless Protocols: Wireless and wired communication, wireless protocols:Wi-Fi,, Wi-Fi direct, Zigbee, z-wave, Bluetooth, RF, LowPAN, GPRS/3G/LTE, NFC.- Definition, Architecture and characteristics.

Targeted Application & Tools that can be used:
Targeted Applications: 4G, AMQP, Bluetooth and BLE, Cellular, Communication, Artificial Intelligence
Professionally Used Software: Ardunio, Flutter, Eclipse IOT, Rasberry PI, NOD-RED

Text Book(s):

42. Raj Kamal, "Internet of Things-Architecture and design principles, 2nd Edition, McGraw Hill Education, 2022.
43. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", 1st Edition, John Wiley, 2005.

Reference(s):
Reference Book(s):

1. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
2. KazemSohraby, Daniel Minoli, &TaiebZnati, Wireless Sensor Networks-Technology, Protocols, and Applications, John Wiley, 2007.
3. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Online self-paced course :- https://www.udemy.com/course/wireless-technologies-for-iot/
2. Udemy Coursehttps://www.udemy.com/course/iot-protocols-pna/
3. Coursera online video: https://www.coursera.org/lecture/iot-devices-il/lecture-7-iot-protocols-WmhKs
4. NPTEL Video Lectures: https://onlinecourses.nptel.ac.in/noc22_cs53/preview

E-content:

1. RAY P. P.,"A survey on Internet of Things architectures" Journal of King Saud University - Computer and Information Sciences, 30(3), pp. 291-319, 2018. ISSN: 1319-1578. https://www.sciencedirect.com/science/article/pii/S1319157816300799?via%3Dihub
2. Bhawana Rudra, "Impact of Block chain for Internet Of Things Security", Crypto currencies and Blockchain Technology Applications, pp.99, 2020.https://onlinelibrary.wiley.com/doi/book/10.1002/9781119621201

. Topics related to development of "EMPLOYABILITY": Communication Protocols for developing Employability skill through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Mrs. Amrutha V Nair
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

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Course Code: ECE3078	**Course Title: IoT and Cloud Computing** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**		**L-T-P- C**	3	**0**	**0**	**3**
Version No.	2.0					
Course Pre-requisites	Basics of Network Protocols					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students about the Computing basics and its services which include SaaS, PaaS, and IaaS. It also deals with different types of cloud such as Google, Amazon, IBM, Redhat, Microsoft and Salesforce.com					
Course Objective	The objective of the course is to familiarize the learners with the concepts of IoT and Cloud Computing and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the various concept of Cloud Computing. 2. Explain the Concept of Broad Network Access 3. Interpret Application Programming Interface (API) and Cloud Deployment Models. 4. Analyze of various service platforms					
Course Content:						
Module 1	**Overview and Introduction of Computing**	Assignment / Quiz	Implementation using Simulation tools		**14 sessions**	
Topics: Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. Evolution of cloud computing - Business driver for adopting cloud computing. Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers. Properties, Characteristics & Disadvantages - Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing. Role of Open Standards.						
Module 2	**Cloud Computing Architecture**	Assignment / Quiz	Implementation using Simulation Tools		**13 sessions**	
Topics: Cloud computing stack - Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services. Service Models (XaaS) - Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Deployment Models, Public cloud, Private cloud, Hybrid cloud, Community cloud.						
Module 3	Platform as a Service	Assignment / Quiz	Implementation using		**12 sessions**	

	(PaaS)		Simulation Tools	

Topics:
Platform as a Service(PaaS) What is PaaS, Service Oriented Architecture (SOA), Cloud Platform and Management, Examples like Google App Engine. storage as a service, Data storage in cloud computing (storage as a service). Renting, EC2 Compute Unit, Platform and Storage, pricing, customers.

Targeted Application & Tools that can be used:
Targeted Applications: Computing in all of the IoT applications connected to server.
Professionally Used Software: Python , Eclipse , Thinger.io

Project work/Assignment:

Project Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
3. Project Assignment:- Implementation of various concepts in from deep learning using Python/ MATLAB/ SCILAB

Textbook(s):

1. Cloud Computing for Dummies by Judith Hurwitz, R. Bloor, M. Kanfman, F. Halper (Wiley India Edition).
2. Enterprise Cloud Computing by Gautam Shroff, Cambridge.
3. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India

Reference(s):

1. Duda, R.O. and Hart, P.E., Pattern Classification and Scene Analysis, John Wiley.
2. Apalpaydin E, Introduction to Machine Learning, MIT Press.
3. K. Mehrotra, C. Mohan and S. Ranka, "Elements of Artificial Neural networks, MIT Press.

Online Resources (e-books, notes, ppts, video lectures etc.):

1.Free online course:- https://www.udemy.com/course/building-cloud-infrastructure-with-terraform/ , Coursera - https://www.coursera.org/learn/introduction-to-cloud
2. NPTEL Video content: NPTEL - https://onlinecourses.nptel.ac.in/noc22_cs20/preview
3. online Notes - https://www.coursera.org/learn/introduction-to-cloud,https://gpmeham.edu.in/wp-content/uploads/2020/09/E-NOTES_OF_CLOUD_COMPUTING-3.pdf
4.Online PPTs - https://www.slideshare.net/OECLIBOdishaElectron/cloud-computing-ppt-79142235

E-content:

1. S. Z. Mohammadi and J. N. Navimipour, "Invalid cloud providers' identification using the support vector machine," International Journal Of Next-Generation Computing, vol. 8, no. 1, 2017. https://ijngc.perpetualinnovation.net/index.php/ijngc/article/view/122
2. Q. Zhang, L. Cheng, and R. Boutaba, "Cloud computing: state-of-the-art and research challenges," Journal of internet services and applications, vol. 1, no. 1, pp. 7–18, 2010. https://jisajournal.springeropen.com/articles/10.1007/s13174-010-0007-6
3. K. A. Rodrigues de Castro, "Feasible community cloud architecture for provisioning infrastructure as a service in the government sector," in Proceedings of the 20th Annual International Conference on Digital Government Research, pp. 35–40, Dubai, United Arab Emirates, June 2019.

https://www.researchgate.net/publication/360118887_Descriptive_Literature_Review_and_Classification_of_Community_Cloud_Computing_Research?_sg%5B0%5D=started_experiment_milestone&_sg%5B1%5D=started_experiment_milestone	
Topics related to development of "EMPLOYABILITY": Data storage in cloud computing (storage as a service) Platform and Storage, pricing, customers for developing Employability skill through Participative Learning techniques. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Ms. Anupama Sindgi
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3079	**Course Title: Fog Computing** **Type of Course: Discipline Elective-IOT and Sensor Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Knowledge of Advanced Wireless Networks						
Anti-requisites	**NIL**						
Course Description	This course gives an overview of Fog Computing and its architecture, challenges and applications in different context. The course will provide solid base for understanding the challenges and problems underlying the design and development of fog computing systems and applications.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Fog Computing and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of the course the students shall be able to: 1. Illustrate the concepts of fog computing in communication technology 2. Develop the fog computing based IoT application by using integrated architectural model 3. Make use of advanced fog computing concepts in health monitoring and smart transportation applications. 4. Examine the importance of fog computing based real time applications						
Course Content:							
Module 1	Introduction to Fog Computing	Assignment/ Quiz	Memory Recall based Quizzes	11 Sessions			
Topics: **Introduction to Fog Computing:** Fog Computing, Characteristics, Application Scenarios, Issues and challenges. **Fog Computing Architecture:** Communication and Network Model, Programming Models, Fog Architecture for smart cities, healthcare and vehicles. **Fog Computing Communication Technologies:** Introduction, IEEE 802.11, 4G, 5G standards, WPAN, Short-Range Technologies, LPWAN and other medium and Long-Range Technologies							
Module 2	FOG Computing in IoT	Assignment/ Quiz	Memory Recall based Quizzes	11 Sessions			
Topics: **Fog computing requirements when applied to IoT:** Scalability, Interoperability, Fog-IoT architectural model, Challenges on IoT Stack Model via TCP/IP Architecture, Data Management, filtering, Event Management, Device Management, cloudification, virualization, security and privacy issues. **Integrating IoT, Fog, Cloud Infrastructures:** Methodology, Integrated C2F2T Literature by Modeling Technique re by Use-Case Scenarios, Integrated C2F2T Literature by Metrics.							
Module 3	Fog Computing in Health Monitoring	Assignment/ Quiz	Memory Recall based Quizzes	9 Sessions			
Topics: **Exploiting Fog Computing in Health Monitoring:** An Architecture of a Health Monitoring IoT-based System with Fog Computing, Fog Computing Services in Smart E-							

Health Gateways, Discussion of Connected Components.

Module 4	Fog Computing in Smart Transportation	Assignment/ Quiz	Memory Recall based Quizzes	9 Sessions

Fog Computing Model for Evolving Smart Transportation Applications: Introduction, Data-Driven Intelligent Transportation Systems, **Fog Computing for Smart Transportation Applications Case Study:** Intelligent Traffic Lights Management (ITLM) System.
Security and Privacy issues: Machine Learning based security in Fog Computing.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: Solutions needed in IOT to help with decision-making in the real world.
Professionally Used Software: Phython, C

Text Books:

1. Assad Abbas, Samee U. Khan and Albert Y. Zomaya, Fog Computing: Theory and Practice, 1st Edition, Wiley Publisher, 2020,ISBN: 978-1-119-55169-0.
2. Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms, Wiley Publisher, 2019, ISBN: 9781119524984.
3. Sudip Misra, Subhadeep Sarkar, Subarna Chatterjee, Sensors, Cloud, and Fog: The Enabling Technologies for the Internet of Things, 1st edition, CRC Press, 2019, ISBN 9780367196127.

Reference(s):
Reference Books

1. Nik Bessis, Ciprian Dobre, Big Data and Internet of Things: A Roadmap for Smart Environments, Studies in Computational Intelligence 546, Springer, 2014, ISBN-13: 978-3319050287

Online Resources (e-books, notes, ppts, video lectures etc.):

13. NPTEL Video lectures on "Fog Computing" by Prof. Dr. Sudip Misra", IIT Kharagpur, (560) FOG COMPUTING- I - YouTube, (560) FOG COMPUTING- II - YouTube
14. Coursera Video lecture on fog computing by Jong-Moon Chung, Professor, School of Electrical & Electronic Engineering, YONSEI University, 5.11 Fog Computing - Cloud Technology | Coursera

E-content:

1. A Survey of Fog Computing: Concepts, Applications and Issues, Shanhe Yi, Cheng Li, Qun Li, Mobidata'15, June 21, 2015, Hangzhou, China. DOI: http://dx.doi.org/10.1145/2757384.2757397.

2. Flavio Bonomi, Rodolfo Milito, Preethi Natarajan and Jiang Zhu, Fog Computing: A Platform for Internet of Things and Analytics, Springer International Publishing Switzerland 2014, DOI: 10.1007/978-3-319-05029-4_7.

3. Amir Vahid Dastjerdi and Rajkumar Buyya, Fog Computing: Helping the Internet of Things Realize its Potential, University of Melbourne, Computer 49(8):112-116, DOI: 10.1109/MC.2016.245

Topics related to development of "EMPLOYABILITY": Integrating IoT, Fog, Cloud Infrastructures for developing Employability skill through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Ms. Samreen Fiza,
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3080	**Course Title: IOT Edge Nodes and its Applications** **Type of Course : Discipline Elective- IOT and Sensor Technologies Basket**	**L-T- P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Concepts of Data Communication and Computer Networks Embedded Systems.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of IOT and IOT based Edge nodes and systems to provide students with a good depth of knowledge of designing Industrial IOT Systems for various applications. The course emphasizes on the IIOT architecture, Computing types, IOT Connecting technologies for IOT edge node.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of IOT Edge Nodes and its Applications and to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using open source Design Tools.					
Course Outcomes	On successful completion of this course the students shall be able to: **1.** Summarize the concept of IOT/IIOT and architecture of IoT/IIOT. **2.** Generalize the computing types and highlight its importance in edge computing. **3.** Demonstrate the computing types and highlight its importance in edge computing. **4.** Illustrate Legacy Industrial and Modern Communication Protocols and Middleware Architecture, LoRaWAN- and augmented reality.					
Course Content:						
Module 1	**Introduction to IoT**	Assignment	Memory Recall based Quizzes	**10 session**		
Topics: Overview and Basic concepts of IoT, IoT architecture and components, - Sensors, Interface, Networks, Key terms – IOT Platform, Interfaces, clouds, Data Analytics, Challenges. Various Architectures of IOT, Advantages & disadvantages. Physical Design of IoT, Logical Design of IoT, IoT enabling Technologies, IoT Applications.						
Module 2	**Introduction to IIOT and the technical and business Innovators of Industrial Internet**	Assignment	Memory Recall	**10 session**		
Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT, Role of edge nodes in IoT. The Technical & Business Innovators of Industrial Internet: Miniaturization, Cyber Physical Systems, Wireless Technology, IP Mobility, NFV, Cloud and Fog, Big Data & Analytics, M2M & Artificial Intelligence, Augmented Reality, 3D Printing. IIOT Reference architecture.						
Module 3	**Introduction to Edge Computing and Challenges in Federating Edge Resources:**	Assignment	Analysis and Verification	**10 session**		
Topics: Edge Computing Fundamentals: Definition and importance of edge computing, Differences between edge and cloud computing, Advantages and challenges of edge computing. IoT						

Edge Node Components: Sensors and actuators, Microcontrollers and processors, Communication modules and protocols, Power management in edge nodes. Relevant Technologies of Edge Computing, Cloud-Hierarchy of Edge Computing-Business Models-Opportunities and Challenges in Federating Edge Resources, and Orchestration of Network Slices in 5G, Edge, and Clouds				
Module 4	**Protocols, Middleware Software Patterns and user case study for Industrial Internet Systems:**	Quiz	Application	**10 session**
Modern Communication Protocols-Proximity Network Communication Protocols- Wireless Communication Technologies- Gateways: industrial gateways - CoAP (Constrained Application Protocol)- NFC. Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS- Middleware Architecture- SigFox- LoRaWAN Augmented reality- Real-World Smart Factories, Application of IIOT: Case study: Health monitoring, IoT smart city, Smart irrigation, Robot surveillance.				

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Network and Structure, Device and Hardware, Cloud management.
Professionally Used Software – MATLAB, Embedded-C/C++ and Python.

Text Book(s):

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach",3rd Edition, Universities Press, 2015.
2. Ovidiu Vermesan, Peter Friess, "Internet of Things – From research and innovation to market deployment", 1st Edition, River Publishers Series in Communication, USA, 2014.
3. Gilchrist, Alasdair, "Industry 4.0 The Industrial Internet of Things", Apress, 2017.
4. Rajkumar Buyya, Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", 1st Edition, Wiley, 2019

Reference(s):

1. David Boswarthick, "M2M Communications – A Systems Approach", 1st Edition, Wiley, USA, 2012.
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice" , 1st Edition, Wiley Publications 2010
3. Dr. Ovidiu Vermesan, Dr. Peter Friess , "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems" , 1st Edition, River Publishers 2013.
4. Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann , "Interconnecting Smart Objects with IP: The Next Internet" , 1st Edition, Elsevier, 2010.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Course on "Introduction to internet of things", Prof. Sudip Misra, IIT Kharagpur, https://nptel.ac.in/courses/106/105/106105166/
2. NPTEL Course on "Design for internet of things", By Prof. Prabhakar T V, IISc Bangalore, https://onlinecourses.nptel.ac.in/noc21_ee85/preview
3. NPTEL Course on " Introduction To Industry 4.0 And Industrial Internet Of Things", By Prof. Sudip Misra, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc22_cs52/preview

E-content:

1. He Li, Kaoru Ota, Mianxiong Dong, "Learning IoT in Edge: Deep Learning for the Internet of Things with Edge Computing", IEEE Network, Volume: 32, Issue: 1, Feb. 2018, pp:96 - 101, DOI: 10.1109/MNET.2018.1700202, https://ieeexplore.ieee.org/document/8270639
2. Yao-Chung Chang, Ying-Hsun Lai, "Campus Edge Computing Network Based on IoT Street Lighting Nodes", IEEE Systems Journal, Volume: 14, Issue: 1, March 2020, pp:164 - 171

<table>
<tr><td colspan="2">https://ieeexplore.ieee.org/document/8490873
3. Wei Yu, Fan Liang, Xiaofei He, William Grant Hatcher, Chao Lu, Jie Lin, And Xinyu Yang, "A Survey On The Edge Computing For The Internet Of Things", Special Section On Mobile Edge Computing, IEEE Access, Volume 6, 2018, pp:6900-6919 https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8123913
4. Muhammad Ayaz, Mohammad Ammad-Uddin, Zubair Sharif, Ali Mansour, El-Hadi M. Aggoune, "Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk", IEEE Access, Volume: 7,pp:129551-129583,DOI:10.1109/ACCESS.2019.2932609, https://ieeexplore.ieee.org/document/8784034</td></tr>
<tr><td colspan="2">Topics related to development of “EMPLOYABILITY”: Developing applications through IoT tools for developing Employability skill through Experiential Learning techniques. This is attained through assessment component mentioned in course handout</td></tr>
<tr><td>Catalogue prepared by</td><td>Mrs. Annapurna. H.S,</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 19th BOS held on 06/07/2024</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 24th , Dated 03/08/2024</td></tr>
</table>

Course Code:ECE3081	**Course Title:Security and Privacy in Traditional IoT Systems** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basic understanding of Microprocessors and Microcontroller. Interfacing of Raspberry pi. Basic knowledge of computer system architecture.						
Anti-requisites	NIL						
Course Description	The course is designed for intermediate users of IoT, with basic understanding of IoT and other allied systems; one should be able to implement security and privacy in traditional IoT systems to enhance the workability and trustworthiness of the overall deployed system. It focusses on a systematic approach of studying the vulnerabilities and countering them using available techniques and algorithms.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Security and Privacy in Traditional IoT Systems and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the areas of cyber security for the Internet of Things. 2. Assess different Internet of Things technologies and their applications. 3. Model IoT to business 4. Customize real time data for IoT applications. 5. Identify various applications and use cases of IoT						
Course Content:							
Module 1	**Introduction to IoT – Cyber Physical Systems**	Quiz	Memory Recall based Quizzes	**10 Classes**			
Topics:IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle. Network Robustness of Internet of Things- Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems							
Module 2	**IoT Standards and Applications**	Assignment / Quiz	Memory Recall Based	**10 Classes**			
Topics: IoT standards in practice, Operating platforms and systems, design of IoT systems, development of prototypes, Applications: Lighting as a service, Smart Parking and Smart water management, Challenges in Mission critical applications and big data management.							
Module 3	**Privacy Preservation and Trust**	Assignment	System Design Based	**12 Classes**			

	Models			
Topics: Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things.				
Module 4	**IoT Security and Recent Trends**	Assignment	System Design Based	**07 Classes**
Topics: Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security-IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links in IoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs, Commercialized Products.				

Textbook(s):

1. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition, Press, 2016.
2. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1st edition, Packt Publishing Ltd, 2016.

Reference Book(s):

1. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1 st edition, NCC Group, 2014 2. DaCosta, Francis, and Byron Henderson.
2. Rethinking the Internet of Things: a scalable approach to connecting everything, 1 st edition,Springer Nature, 2013.

E-Content:

1. Scalable and Configurable End-to-End Collection and Analysis of IoT Security Data : Towards End-to-End Security in IoT Systems **https://ieeexplore.ieee.org/document/8766407**
2. An In-Depth Analysis of IoT Security Requirements, Challenges, and Their Countermeasures via Software-Defined Security **https://ieeexplore.ieee.org/document/9099839**
3. A Review of Security Standards and Frameworks for IoT-Based Smart Environments **https://ieeexplore.ieee.org/document/9528421**
4. Analysis of network security and privacy security based on AI in IOT environment **https://ieeexplore.ieee.org/document/9590786**

Online Resources (e-books, notes, ppts, video lectures etc.):

1. **Free online self-paced course :- https://bcourses.berkeley.edu.**
2. **Online notes :- https://mitpress.mit.edu/books/internet-things**
3. **https://www.udemy.com/course/securing-iot-from-security-to-practical-pentesting-on-iot/**
4. **https://www.udemy.com/course/fundamentals-of-iot-systems/**

Topics related to development of "EMPLOYABILITY": Integrating Deploying secured IoT to enterprise solutions for developing Employability skill through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared	Nipun Sharma

by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3082	**Course Title: Data Science for IOT** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**		**L-T-P-C**	**3**	**0**	**0**	**3**
Version No.	2.0					
Course Pre-requisites	**Basic concepts of Microprocessor programming and memory interfacing, knowledge of Python and Embedded C.**					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to support the students to understand the fundamentals of Data Science and Internet of Things (IOT) along with real time applications. The course will give awareness to students, about how two independent technologies depend on each other. This course explains students about how IOT would collect data from physical objects through different sensors, and how big data will allow the faster and more efficient storage and processing of data. This course will make students to understand the meaning of big data, which is to process a large amount of data on real time basis by using different storage technologies. This course will help the students who want to choose their career as Data Scientists or IOT Analyst and also encourage students to become entrepreneurs to launch new products in IOT and Data Science.					
Course objective	The objective of the course is to familiarize the learners with the concepts of Data Science for IOT and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	**On successful completion of this course the students shall be able to:** **CO1**: Explain the various concepts, terminologies and architecture of IOT systems. **CO3**: Recognize the role of big data, cloud computing and data analytics in a typical IOT system. **CO3:** Interface a node MCU to collect online data and carry out the computation.					
Course Content:						
Module 1	**Fundamentals of IOT**	Assignment/Quiz	IOT architectures, Frameworks and M2M	**15Sessions**		
Introduction, Definitions & Characteristics of IOT, IOT Architectures, Physical & Logical Design of IOT, Enabling Technologies in IOT, History of IOT, About Things in IOT, The Identifiers in IOT, About the Internet in IOT, IOT frameworks, IOT and M2M						
Module 2	**Data Handling& Analytics**	Project	Data Analysis task	**15Sessions**		
Introduction, Big data, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications						
Module 3	**Applications of IOT**	Assignment	Real time applications	**10Sessions**		
What is ESP8266 node-MCU ☐ Hardware Knowledge ☐ Hand Shake with ESP8266 ☐ Developing the Environment ☐ Overview about the board. Home Automation - Creating						

Webpage Button, Adding up required WEBPGE Elements Controlling Devices

Targeted Application & Tools that can be used:

Application Areas: Machine Learning, Deep Learning, Security Application, Home Automation, Wireless Communication in telecom industries.

Professionally Used Software: Python, Embedded C, google cloud fire base

Text Book(s):

4. HakimaChaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN: 978-1- 84821-140-7, Wiley Publications.Edition-1
5. Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", Wiley Publications. Edition-2

References:

7. Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications Digital Signal Processing, 2/E Ganesh Rao, Pearson Education, Edition-1

Online Resources (e-books, notes,ppts,Video lectures) :

1. Nptel video lectures on Introduction to internet of things by Prof. Sudeep Mishra, IIT Kharagpur-

https://nptel.ac.in/courses/106/105/106105166/

2. Nptel video lectures on Data Sciencefor Engineers, IIT madras by Prof. Shankar Narasimhan and Prof.

Ragunathan Rangaswamy- **https://nptel.ac.in/courses/106/106/106106179/**

3. Online material (PDF) on IOT Protocols and Standards

http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

4. https://presiuniv.knimbus.com/user#/home

E-Content:

1. Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications Ala Al-Fuqaha, Mohsen Guizani, Mehdi Mohammadi, Mohammed Aledhari and Moussa Ayyash Volume: 17, Issue: 4, Fourthquarter 2015 DOI: 10.1109/COMST.2015.2444095.

2. IEEE 1905.1-2013, "IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies," 93 pp., April 12 2013, http://ieeexplore.ieee.org/document/6502164/

3. A Survey of Data Partitioning and Sampling Methods to Support Big Data Analysis Mohammad Sultan Mahmud, Joshua Zhexue Huang, Salman Salloum , Tamer Z. Emara, and Kuanishbay Sadatdiynov, BIG DATA MINING AND ANALYTICS Volume 3, Number 2, June 2020. DOI: 10.26599/BDMA.2019.9020015.

4. Multi-Attention Fusion Modeling for Sentiment Analysis of Educational Big Data Guanlin Zhai, Yan Yang , Heng Wang, and Shengdong Du369, BIG DATA MINING AND ANALYTICS ISSN 2096-0654 06/06 pp311–319 Volume 3, Number 4, December 2020 DOI: 10.26599/BDMA.2020.9020024.

Topics related to development of "EMPLOYABILITY"**:** Home Automation, Smart Cities for developing Employability skill through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue	Dr. K BhanuRekha Ms. R Anusha

prepared by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3083	**Course Title: Hardware and Software Architecture for secured IoT Systems** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basic understanding of communication protocol stacks. Interfacing of Raspberry pi. Assembly language programming and computer system architecture knowledge.						
Anti-requisites	NIL						
Course Description	The course aims at studying holistically the software and hardware architectures of IoT Systems for better understanding of deployment in the real world. As both the architectures work in conjunction with each other so the course aims at systematically exploring key anchor points between the two and how they can create a functional IoT system.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Hardware and Software Architecture for secured IoT Systems and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of Internet of Things (IoT). 2. Analyze, design and develop IoT solutions. 3. Identify software and hardware requirements to design IoT Systems 4. Apply the concept of Internet of Things in the real-world scenarios						
Course Content:							
Module 1	**IoT Fundamentals and Reference Architecture, Software Design**	Quiz	Memory Recall based Quizzes	**10 Classes**			
Topics: Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security. Control Units – Communication modules – Bluetooth – Zigbee – WIFI – GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP etc..), MQTT, Wired Communication, Power Sources							
Module 2	**Programming the microcontroller for IoT**	Assignment / Quiz	Programming and Simulation task	**10 Classes**			
Topics: IOT structure - RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IOT Enabling Technologies - BigData Analytics, Cloud Computing, Embedded Systems. Working principles of sensors – IOT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication.							
Module 3	**Resource management and Web of Things**	Assignment	Simulation Tasks	**12 Classes**			

Topics: Clustering, Clustering for Scalability, Clustering for routing, Clustering Protocols for IOT The Future Web of Things – Set up cloud environment –Cloud access from sensors– Data Analytics for IOT- Rest Architectures- The web of Things				
Module 4	**Hardware and Software of IoT**	Assignment	System Design Task and Analysis	**07 Classes**
Topics: IoT Physical Devices and Endpoints – Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins. IoT Physical Servers and Cloud Offerings – Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API				
Project work/Assignment:				
Project Assignment: Implementing Cloud services on Decentralized platforms. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done. **Students will be made into group and given the programming assignment at the end of each module. Students need to use IoT Development Kits like Azure for these assignments.** **Tools:** **1. Arduino IDE, Arduino Cloud** **2. IoT Cloud Remote, Web Editor**				
Textbook(s): **1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 1 st edition, Wiley Publications, 2019.** **2. Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A hands-on approach, 1st edition, University press, 2014.** **Reference Books:** 3. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1 st edition, NCC Group, 2014 2. DaCosta, Francis, and Byron Henderson. 4. Rethinking the Internet of Things: a scalable approach to connecting everything, 1 st edition, Springer Nature, 2013. **E-Content:** **1.** A Taxonomy of IoT Client Architectures **https://ieeexplore.ieee.org/document/8354417** 2. Software-Defined Edge Computing (SDEC): Principle, Open IoT System Architecture, Applications, and Challenges https://ieeexplore.ieee.org/document/8907456 3. Software Test Architectures and Advanced Support Environments for IoT https://ieeexplore.ieee.org/document/8411760 4. A Remotely Configurable Hardware/Software Architecture for a Distance IoT Lab https://ieeexplore.ieee.org/document/9556236 **Online Resources (e-books, notes, ppts, video lectures etc.):** 1. https://www.udemy.com/course/embedded-electronics-bootcamp-from-bit-to-deep-learning/ 2. https://nptel.ac.in/courses/106105159 3. https://rfwireless-world.com/IoT/IoT-architecture.html 4. https://www.udemy.com/course/iot-solution-with-esp32-and-aws/				
Topics relevant to development of "EMPLOYABILITY SKILLS": Topics relevant to "EMPLOYABILITY SKILLS": System Design and Process Control in IoT, Leading skills for IoT computing are system design, architecture privacy and security **for developing Employability Skills through Participative Learning techniques. This is attained**				

through assessment component mentioned in course handout.	
Catalogue prepared by	Nipun Sharma
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3084	**Course Title: Mobile App Development for IoT** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**		**L- T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basics of mobile device architecture, basics of computer communication concepts and programming languages used for mobile applications and also software engineering and mobile interfacing with different sensors for IoT Applications. The course emphasizes on working, analysis and design of mobile communication application for IoT. Additionally, this course will create a foundation for future courses such as secured mobile based communication for IoT based application.						
Anti-requisites	**NIL**						
Course Description	This is an advanced research-oriented course designed for undergraduate students. This course deals with fundamentals of Android operating systems and also development of software with reasonable complexity on mobile platform.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Mobile App Development for IoT and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques						
Course Outcomes	On successful completion of this course the students shall be able to: 1: Apply advanced techniques and tools of sensing and computation for industry 4.0 problems for the benefit of society. 2: Strong cognizance in the area of app development, sensors, IoT for mobile communication, data science and signal processing through the application of acquired knowledge and skills. 3: To learn how to develop Mobile Applications for IoT 4: Evaluate the wireless technologies for IoT.						
Course Content:							
Module 1	Introduction	Quiz	Memory Recall based Quiz	**8 sessions**			
Topics: Sensors and actuators, introduction to industry 4.0, development of mobile App, application and architecture of data link layer. Introduction to smart sensors							
Module 2	IoT devices and mobile networking protocols	Assignment /Quiz	Theory	**7 sessions**			
Topics: IoT Devices and Networking Protocols: IoT devices, Networking basics, Data link protocol: IEEE 802.15.4, IEEE 802.11 AH, Wireless HART, Z-Wave, Bluetooth low energy, Zigbee , Wi-Fi, 4G/LTE, LTE-A.							
Module 3	Evolution of IoT for Mobile Applications	Assignment	Memory Recall based Quiz	**7 sessions**			
Topics: Review of computer communication **concepts** (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges).IPV6							

addressing. IoT architecture reference layer.

Module 4	IoT point to point Mobile communication technologies	Assignment	Comprehension based Quizzes and assignments	**8 sessions**

IOT communication Technologies : IOT network design and cloud networks, networking technologies for data centers, software designed networking, network virtualization techniques, Adaptive and cognitive networks, wireless networks for IOT and cloud

+Digital Content :

NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview
Udemy - https://www.udemy.com/course/pcb-design-and-fabrication-for-everyone/
Coursera - https://www.coursera.org/lecture/leds-semiconductor-lasers/introduction-to-semiconductor-fundamentals-3zejs

E – Leraning materials:

1. https://ieeexplore.ieee.org/document/9576865
2. https://ieeexplore.ieee.org/abstract/document/9227661

Research Papers :

4. William Cheng-Yu Ma;Yan-Jia Huang;Po-Jen Chen;Jhe-Wei Jhu;Yan-Shiuan Chang;Ting-Hsuan Chang ,"Impacts of Vertically Stacked Monolithic 3D-IC Process on Characteristics of Underlying Thin-Film Transistor" , IEEE Journal of the Electron Devices Society 2020 , https://ieeexplore.ieee.org/document/9141258

5. NEGIN ZARAEE 1 , BOYOU ZHOU 1 , KYLE VIGIL 2 , MOHAMMAD M. SHAHJAMALI 3 , AJAY JOSHI 1 , AND M. SELIM ÜNLÜ , "Gate-Level Validation of Integrated Circuits With Structured-Illumination Read-Out of Embedded Optical Signatures" , IEEE,2020, https://ieeexplore.ieee.org/document/9063443

Topics Relevant to development of "Employability Skills": Sensors and Actuators, App development for developing **Employability Skills** through **Participative Learning techniques.** This is attained through assessment component mentioned in course handout.

Targeted Application & Tools that can be used:

Application Areas: Home automation, Agriculture, Retail, Smart city, self-driven cars, wearables, Industrial internet
Professionally Used Software: Python, Embedded C, Eclipse, React Native, Android studio

1) **Project Work: Development of IoT enabled - Smart watch, Cameras, Fitness meter etc.**

Assignment:

1. **We will be able to find IoT examples in all parts of our lives. Use the reading assignments and online search to identify a concrete example of an IoT system (existing or futuristic) in each of the following application areas: home, healthcare, transportation, and community (i.e., four**

examples in total). For each example, provide a description of what the problem is that the IoT solves, how it solves it, who the users are, and what a risk of the example is (e.g., in terms of ethical concerns, privacy, safety, etc.). Limit each example description to 200 words.

2. **Write a client-server based intruder detection system using 2 Pis, a PIR sensor, and an LED (and/or sounder). Student need to collaborate with one or more of his/her classmates for this task, i.e., student will need to test his/her client and server programs on two Pis simultaneously. One Pi will have the PIR sensor connected, the second Pi will operate the LED and/or sounder. The server Pi will use a callback function for motion detected by the PIR. The other Pi acts as client and queries the server for the PIR value once every 5 seconds; if an intrusion is detected, the alarm is raised (e.g., flashing LED or activated sounder).**

3. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in an appropriate format.

Text Book(s):

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016

2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.

(i)Reference(s)

1. Plummer J. D., Deal M. D. and P. B. Griffin , "Silicon VLSI Technology: Fundamentals, Practice and Modeling" , Pearson/PHI, 2001.

2. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally f Things A Hands-on-Approac h" Arshdeep Bahga & Vijay Madisetti, 2014.

3. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010

(ii) Website:

- http://ai2.appinventor.mit.edu
- https://drive.google.com/file/d/0B8rTtW_91YclTWF4czdBMEpZcWs/view

Catalogue prepared by	Dr.Veena CS
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3085	**Course Title: Security and Privacy in Edge Native Solutions** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic understanding of Microprocessor and microcontroller RISC and CISC hardware, ARM processors. Interfacing of Raspberry pi. Basics of blockchain and Bitcoin and inclination towards cryptocurrencies, NFTs and enterprise solutions					
Anti-requisites	NIL					
Course Description	The course aims at studying the security and privacy issues in Edge Native Solutions architectures of IoT Systems for better understanding of deployment in the real world. As both the aspects work in tandem with each other so the course aims at systematically exploring key anchor points between the two and how they can create a secure Edge Native IoT system.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Security and Privacy in Edge Native Solutions and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the areas of cyber security for the Edge Native Computing. 2. Assess different Internet of Things technologies and their applications. 3. Implement Model Edge Native Solutions to enterprise with Authentication 4. Incorporate security systems using elementary blocks					
Course Content:						
Module 1	**IOT SECURITY AND TRUST MODELING**	Quiz	Memory Recall based Quizzes	**10 Classes**		
Topics: Cyber Security vs IoT Security, IoT common protocols, IoT vulnerabilities, IoT attacks, IoT risks, IoT countermeasures, Cryptography, Trust Models, Merkle trees, elliptic curves, public-key crypto(PKI), signature algorithms						
Module 2	**INTRUSION AND ANOMALY DETECTION**	Assignment / Quiz	Simulation Based	**10 Classes**		
Topics: Attacks in IoT ecosystems, Intrusion detection datasets, challenges in IoT IDS. Authentication in IoT- Computational Security for the IoT.						
Module 3	**SECURE COMMUNICATION NETWORK AND PROTOCOLS for IoT**	Assignment	Memory Recall based Quizzes	**12 Classes**		
Topics: Application layer Protocols for security IETFs CoAP, IBMs MQTT,IPv4/IPv6, RPL, 6LoWPAN (adaption) XMPP, AMQP, Transport Layer: UDP, DTLS, TCP, Network Layer.						
Module 4	**IOT Authentication and Access Control**	Assignment	Design Based	**07 Classes**		
Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things.						
Project work/Assignment:						
Project Assignment: Case Studies of Enterprises utilizing Permissioned blockchain for building Trust and						

maintaining security.
Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.
Students will be made into group and given the programming assignment at the end of each module. Students need to use IoT Development Kits like Azure for these assignments.
Tools:

1. Arduino IDE, Arduino Cloud
2. IoT Cloud Remote, Web Editor

Textbook(s):

1. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition, Press, 2016.
2. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1st edition, Packt Publishing Ltd, 2016.

Reference Books:

1. Shibu, K. V. Introduction to embedded systems, 1 st edition, Tata McGraw-Hill Education, 2009. Vahid, Frank, and Tony D. Givargis. Embedded system design: a unified hardware/software introduction, 1 st edition, John Wiley & Sons, 2006.
2. Zhu Y. Embedded Systems with ARM® Cortex-M3 Microcontrollers in Assembly Language and C. E-Man Press; 2014.
3. Wolf W. FPGA-based system design. Pearson education; 2004 Jun 15.

E-Content:

1. Convergence of Edge Services & Edge Infrastructure https://ieeexplore.ieee.org/document/9665021
2. The Seminal Role of Edge-Native Applications https://ieeexplore.ieee.org/document/8812200
3. Towards an Assurance Framework for Edge and IoT Systems https://ieeexplore.ieee.org/document/9711961
4. A Survey of AI Enabled Edge Computing for Future Networks https://ieeexplore.ieee.org/document/9605058

Online Resources (e-books, notes, ppts, video lectures etc.):

1. **https://www.udemy.com/course/introduction-to-edge-computing/**
2. **https://nptel.ac.in/courses/106105159**

Topics relevant to development of "EMPLOYABILITY": Design and system implementation of Entrepreneurial networks for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Nipun Sharma
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3086**	**Course Title: Industrial Internet of Things (IIoT)** **Type of CourseDiscipline Elective- IOT and Sensor Technologies Basket**	**L- T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**Basic concepts of Internet of Things**					
Anti-requisites	**NIL**					
Course Description	The Industrial Internet of Things (IIoT) involves in the *use* of smart sensors and actuators to enhance manufacturing and industrial processes. This course concentrates on the transformation of industrial processes through integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. This course links the automation system with enterprise, planning and product lifecycle.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Demonstrate the importance of Industrial IoT and its layers. 2. Illustrate the role of data analytics and machine learning in IIoT. 3. Ability to identify, formulate and solve problems by using Industrial IoT. 4. Make use of the concepts of IIoT in real applications.					
Course Content:						
Module 1	Introduction	Assignment				**10 Sessions**
Topics: IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, IIoT Reference Architecture-Part I, Part II. Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication.						
Module 2	IIoT Layers	Assignment				**9 Sessions**
Topics: Industrial IoT- Layers: IIoT Communication, IIoT Networking. Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science.						
Module 3	IIoT Data Monitoring and Control	Assignment				**10 Sessions**
Topics: IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology.						
Module 4	Application Domains	Assignment	Case Study			**10 Sessions**
Topics: **I**ndustrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Oil, chemical and pharmaceutical industry, Applications of						

UAVs in Industries, Real case studies

Targeted Application & Tools that can be used:

Application: Industrial IoT is widely used in automated and remote equipment management and monitoring. A student will be able to find job in the following companies

4. Schneider Electric
5. Hewlett Packard
6. Ericsson
7. Oil and Gas Refineries

Professionally Used Software:

1. Exosite ExoSense IoT
2. AWS IoT SiteWise

Text Book(s):

1. Sudip MIsra, Chandana Roy, Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, First Edition, 2021
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, First Edition 2021.

References

1. Giacomo Veneri Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt Publishers, First Edition, 2018
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice" , 1st Edition, Wiley Publications 2010
3. Dr. Ovidiu Vermesan, Dr. Peter Friess , "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems" , 1st Edition, River Publishers 2013**.**
4. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. NPTEL Course on "INTRODUCTION TO INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS" by Dr. Sudip Misra, IIT KGP https://nptel.ac.in/courses/106105195
2. NPTEL Course on "Introduction to internet of things, By Prof. Sudip Misra, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc20_cs66/preview

E-content:

1. Athanasios Bachoumis; Nikos Andriopoulos; Konstantinos Plakas; Aristeidis Magklaras, "Cloud-Edge Interoperability for Demand Response-Enabled Fast Frequency Response Service Provision", IEEE Transactions on Cloud Computing, Volume: 10, Issue: 1, 01 Jan.-March 2022, pp: 123 - 133 https://ieeexplore.ieee.org/document/9560071/authors#authors
2. S. Z. Mohammadi and J. N. Navimipour, "Invalid cloud providers' identification using the support vector machine," International Journal Of Next-Generation Computing, Volume. 8, No. 1, 2017. https://ijngc.perpetualinnovation.net/index.php/ijngc/article/view/122
3. He Li, Kaoru Ota, Mianxiong Dong, "Learning IoT in Edge: Deep Learning for the Internet of Things with Edge Computing", IEEE Network, Volume: 32, Issue: 1, Feb. 2018, pp:96 - 101, DOI: 10.1109/MNET.2018.1700202, https://ieeexplore.ieee.org/document/8270639
4. Yao-Chung Chang, Ying-Hsun Lai, "Campus Edge Computing Network Based on IoT Street Lighting Nodes", IEEE Systems Journal, Volume: 14, Issue: 1, March 2020, pp:164 - 171, https://ieeexplore.ieee.org/document/8490873

Topics related to development of "SKILL DEVELOPMENT": IIoT Sensing, IIoT Processing, IIoT Communication.

Topics related to development of "EMPLOYABILITY": Plant Safety and Security (Including AR

and VR safety applications), Facility Management.	
Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Srilakshmi K H
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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Course Code: ECE3087	**Course Title:** IoT Robots **Type of Course: Discipline Elective-IOT and Sensor Technologies Baske**	**L-T- P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	[1] IoT Robots – ECE3087 Basic concepts of IoT and Robots along with the usage and application of IoT as well as Robots.					
Anti-requisites	NIL					
Course Description	The aim of this course is to enable the students to understand the role of IoT in Robots. This course is both conceptual and application based which imparts the control of Robot using IoT. The comprehensive nature of the course covers a number of quizzes based on IoT and Robots so that students may judge themselves.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Summarize the concept of IoT and architecture for Robots 2. Employ various MAC protocol and routing protocols 3. Demonstrate various feature extraction and event detection techniques using time-domain as well as frequency-domain analysis methods. 4. Employ various parametric and non-parametric models of certain physiological systems in IoT based Robots.					
Course Content:						
Module 1	**IoT Concept an Implementation**	Quiz	Memory Recall based Quizzes			**8 Classes**
Topics: Introduction: IoT concepts, Definition, Characteristics, Components of IoT System, IoT Applications, Physical and logical design of IoT , IoT Standards, Relevance of IoT for the future, Challenges in IoT implementation , IoT for Robot, IoT in Indian Scenario, its opportunities.						
Module 2	**IoT AND M2M**	Assignment / Quiz	Smart objects and Network basics			**10 Classes**
Topics: Introduction, M2M, difference between IoT and M2M, software defined networking (SDN) and network function virtualization (NFV) for IoT, basics of IoT system management with NETCONF-YANG						
Module 3	**Introduction to Robots**	Assignment	Robots and Classification			**10 Classes**
Topics: Robots: Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source. Robot anatomy, configuration of robots, joint notation schemes, work volume, position representation, forward and reverse transformations, Factors influencing the choice of a robot, Types of industrial robots Load handling capacity, general considerations in Robotic material handling.						
Module 4	**Robot Drives and Power Transmission Systems**	Assignment				**12 Classes**
Topics: Robot drive mechanisms: Hydraulic/Electric/Pneumatics, servo & stepper motor						

drives, Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearings. Robot end Effectors: Classification of End effectors – active and passive grippers. Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

Targeted Application & Tools that can be used:
Application Area is Robot applications by implementing IoT for industrial Robots.
Professionally Used Software:

Project work/Assignment:

Project Assignment:

1. **PPT presentation on Introduction to IoT concepts, Applications, use of IoT in Robots**
2. **PPT presentation on Cloud Computing, Real time analytics, Sensor Networks and other related topics.**
3. **PPT presentation on Introduction to Robots, Robot Components, Coordinate Systems.**
4. **PPT presentation on Industrial Robots**
5. **PPT presentation on Robot drives Mechanism and other related topics.**

Assignment: 1: A brief study on survey on Components of IoT, its application and implementation of IoT in Robot.

Assignment 2: Prepare a comprehensive report on role of IoT in Robot and ita application in Industrial Robot.

Textbook(s):

1. John Soldatos (Editor), "Building Blocks for IoT Analytics" , River Publishers.
2. Robotics for Engineers, by Y. Koren, McGraw Hill.
3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGraw Hill.
4. Introduction to Industrial Robotics, by Nagrajan, Pearson India.
5. Robotic Engineering - An Integrated Approach : Richard D. Klafter Thomas A.
6. Robots & Manufacturing Automation, by Asfahl, Wiley.

Reference(s):
Reference Book(s):

1. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities.
2. An Introduction to Robot Technology, by Coifet Chirroza, Kogan Page.
3. Industrial Robots, by Groover, McGraw Hill.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Building Blocks for IoT Analytics, John Soldatos (Editor), River Publishers.
2. MCE Open Course Ware Lecture Notes on "Iot and its Application".
3. Prof. Sudip Misra, NPTEL Lecture Notes and Videos: https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE
4. Kevin Lynch, Modern Robotics, https://www.youtube.com/watch?v=jVu-Hijns70&list=PLggLP4f-rq02vX0OQQ5vrCxbJrzamYDfx
5. Prof. Dilip Kumar Parihar, NPTEL Lecture Notes and Videos: https://www.youtube.com/watch?v=xrwz9IxpMJg
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. J. Y. Lee and J. Lee, " Current Research Trends in IoT Security: A Systematic Mapping Study",
   Hindawi Mobile Information Systems Volume 2021, Article ID 8847099, 25, https://doi.org/10.1155/2021/8847099.
2. J. Gubbi, R. Buyya,S.Marusic, M. Palaniswami, "Internet of Things (IoT): A vision, architectural
   elements, and future directions", Future Generation Computer Systems, vol. 29, 7, 2013, 1645-1660, https://doi.org/10.1016/j.future.2013.01.010.
3. M. A. Khan, K. Salah, "IoT security: Review, block chain solutions, and open challenges", Future Generation Computer Systems, vol 82, 2018, 395-411.
   https://doi.org/10.1016/j.future.2017.11.022.
4. I. Lee, K. Lee, "The Internet of Things (IoT): Applications, investments, and challenges for enterprises", Business Horizons, vol 58, 4,2015,431-440.
   https://doi.org/10.1016/j.bushor.2015.03.008.

Topics relevant to development of "EMPLOYABILITY": Use of IoT in Robot **Topics relevant to "GENDER SENISITASATION":**	
Catalogue prepared by	Dr. Dharmesh Kumar Srivastava
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3088	**Course Title: Internet of Medical Things (IoMT)** **Type of Course: Discipline Elective- IOT and Sensor Technologies Baske**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Internet of Things and Biomedical Engineering					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to appreciate the fundamental of Internet of Medical Things and its application in Healthcare Systems. This course is analytical in nature and needs a fair knowledge about basics of IoT related topics. The focus of the course will be to make health facilities accessible to everyone irrespective of their geographical location. Remote monitoring of the patients is one of the significant aspects of IoMT.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Summarize the architectures of IoMT Devices and their system applications. 2. Apply the IoMT Schema for Remote Patient Monitoring. 3. Examine the operation of Block chain Technology for Privacy-Protection of Medical health records. 4. Analyze the data compression methods for lossless Medical Data Transmission.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Internet of Medical Things (IoMT) and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques					
Course Content:						
Module 1	**Introduction to IoMT**	Quiz	Threats and Challenges of IoMT	**12 Sessions**		
Topics: Introduction to IoMT, IoMT Devices: On-Body Devices, In-Home Devices, Community Devices, In-Clinic Devices, In-Hospital Devices, IoMT System Architecture: Data Collection Layer, Data Management Layer, Medical Server Layer, IoMT Attack Types, Challenges in IoMT Security Schemes.						
Module 2	**Healthcare Schema using IoMT for Remote Patient Monitoring**	Assignment	Solution for Storage and Transfer of Medical Data in IoTM	**10 Sessions**		
Topics: Intelligent Transit Healthcare Schema Using IoMT Networking System: Vibration-Sensing Methodology for Accident Detection, System Safeguards, GPS Integration, Hospital Communication About Accident Location, MCU Connection with the ITH-IoMT Subsystem, GPS-Enabled Module for Location Information, ECG and Health Data Monitoring Schema.						
Module 3	**Privacy Protection of IoMT-Based Health Records using Blockchain Technology**	Assignment	GPS and GUI based medical data storage in EHR	**8 Sessions**		
Topics: Introduction to Blockchain, Applications of Blockchain, Blockchain Advantages and Challenges, Personal Health Data Collection, Virtual Private Server (VPS)-Based Hyperledger Fabric Framework, Remote Monitoring Software Development						

Module 4	**Medical Data Compression for Lossless Data Transmission**	Assignment	Compression methods for telemedicine applications	**8 Sessions**

Topics: Introduction to Medical Data Compression**:** Lossless Compression , Lossy Compression, Significance of Medical Data Compression, Benefits of Medical Data Compression, Characteristics of Data Acquisition and Storage, Data Compression Techniques for Lossless Data Transmission: Coding Scheme, Bandwidth, Storage and Data Compression Techniques.

Targeted Application & Tools that can be used:

Application: It includes complete Healthcare Automation Setup in Medical field with an objective to make health facilities accessible to everyone irrespective of geographical location.
Professionally Used Software: ITM-IoMT System, GPS-GUI System, GPS-Framework uses Global Navigation Satellite System-(GNSS),GPS-gadgets to provide data on location, vehicle speed, time and direction.

QUIZ/Assignment:

1. Project/Programming Assignment: Students will be made into group and given the programming assignment at the end of each module. Students need to use **GPS-GUI** for this assignments.
Sample Assignment 1: Study of wearable smart devices for remote healthcare monitoring to detect cardiac diseases.
Sample Assignment 2: Smart assistance of elderly individuals in emergency situations at home.

2. Book Review/ Article review: A chapter of a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. Presidency University Library Link:- https://presiuniv.knimbus.com/user#/home
Presidency University Library Link .
3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.

Text Book(s):

1. D. Jude Hemanth, J. Anitha George A, Tsihrintzis, *"Internet of Medical Things: Remote Healthcare Systems and Applications"*, 1st Edition, Springer Nature, Switzerland AG 2021, ISSN 2199-1073,ISSN 2199-1081 (electronic), Internet of Things ISBN 978-3-030-63936-5, ISBN 978-3-030-63937-2 (eBook)
   Internet of Medical Things: Remote Healthcare Systems and Applications - Google Books

References
Reference Book(s)

1. Krishna Singh, Mohammed Elhoseny, Akansha Singh, Ahmed Elngar, "Machine Learning and the Internet of Medical Things in Healthcare", 1st Edition-2021, Elsevier Publication.
2. Qusay Hassan, "Internet of Things A to Z: Technologies and Applications", 1st Edition, The Institute of Electrical and Electronics Engineers, Inc. Published 2018 by John Wiley & Sons.

Online resources

1. Video lectures on "IoT Applications: Healthcare" by Prof. Dr. Sudip Misra, Department of Computer Science and Engineering, IIT Kharagpur.
   https://www.youtube.com/watch?v=WmlgDL44PG4

2. E-Book, D. Jude Hemanth, J. Anitha George A, Tsihrintzis, "Internet of Medical Things: Remote Healthcare Systems and Applications", 1st Edition, Springer Nature https://doi.org/10.1007/978-3-030-63937-2.
3. e-Book Series on " Internet of Things" by Giancarlo Fortino, Antonio Liotta, 1st Edition, Springer Nature. Electronic ISSN: 2199-1081 , Print ISSN: 2199-1073, http://www.springer.com/series/11636
4. Video lectures on "Introduction to IoT" by Prof. Dr. Sudip Misra, Department of Computer Science and Engineering, IIT Kharagpur, https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-8QzOAHziEgmjQ2qE

E-content:

1. James, Christopher J., and Christian W. Hesse. "Independent component analysis for biomedical signals." Physiological measurement 26, no. 1 (2004): R15. https://www.academia.edu/download/49895521/0967-3334_2F26_2F1_2Fr0220161026-21959-1bfp9y3.pdf
2. Addison, Paul S. "Wavelet transforms and the ECG: a review." Physiological measurement 26, no. 5 (2005): R155. https://people.uwec.edu/walkerjs/primer/Papers/Addison_EEG_Review.pdf
3. Ce Zheng, Malcolm Egan,Laurent Clavier, Gareth W. Peters & Jean-Marie Gorce EURASIP Journal on Wireless Communications and Networking volume 2022, https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w.
4. Jose David Rodriguez Martinez, "A Wearable Platform for Patient Monitoring during Mass Casualty Incidents", 2018. Karlsruhe: KIT Scientific Publishing. DOI: https://doi.org/10.5445/KSP/1000051989
5. Nicola Carbonaro and Alessandro Tognetti, " Wearable Technologies", Printed Edition of the Special Issue Published in Technologies. MDPI BOOK publications. https://www.mdpi.com/books/pdfview/book/1088
6. https://presiuniv.knimbus.com/user#/home

Topics relevant to "SKILL DEVELOPMENT": IoMT devices used for Medical Application and identify the IoMT architectures **for Skill Development** through **Participative Learning** techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Safinaz S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3095	**Course Title: Blockchain and Cryptocurrency Technologies** **Type of Course: Discipline Elective-IOT and Sensor Technologies Baske**		**L-T-P-C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	NIL						
Anti-requisites	NIL						
Course Description	This course will explore the fundamental elements of blockchain technology and how it applies to cryptocurrencies. It will delve thoroughly into systems for distributed computing like Bitcoin and the blockchain. It will go through decentralized banking implementations, smart contracts, tokens, and the newest stablecoin, as well as how to use digital currencies in the banking industry.						
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Describe Blockchain and its applications. 2. Explain Blockchain Architecture 3. Implement Blockchain Businesses using Ethereum programming 4. Illustrate various cryptocurrencies and their applications.						
Course Content:							
Module 1	INTRODUCTION TO BLOCKCHAIN	Quiz	Memory Recall based Quizzes	**08 sessions**			
Topics: Introduction to Block chain – History, Definition, Distributed Ledger, Blockchain Categories – Public, Private, Consortium, Blockchain Network and Nodes, Peer-to-Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.							
Module 2	BLOCKCHAIN ARCHITECTURE	Assignment / Quiz	Programming and Simulation task	**10 sessions**			
Topics: Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)							
Module 3	BLOCKCHAINS IN BUSINESSES	Assignment	Analysis and Verification	**12 sessions**			
Topics: Public versus private and permissioned versus permission less blockchains; Privacy and anonymity in Ethereum; The Ethereum Enterprise Alliance; Blockchainas-as-a-Service; Initial Coin Offering (ICO) - Project setup for ICO implementation; Token contracts, Token sale contract, Contract security and testing the code.							

Module 4	Cryptocurrencies	Assignment	Case Studies	**12 sessions**

Basics of Cryptocurrency; Creation of coins; Payments and double spending; Bitcoin – Digital Signatures, eWallets, Personal Crypto security; Bitcoin Mining – Mining Hardware, Energy Consumption, Mining Pools, Mining Incentives and Strategies. Privacy and Security issues in Blockchains and Cryptocurrencies.

Targeted Application & Tools that can be used:

Application area is in Secure medical data, Cross-border payments, Real-time IoT operating systems, Personal identity security, Anti-money laundering tracking system, Supply chain and logistics monitoring, Voting mechanism, Cryptocurrency exchange, Real estate processing platform etc.

Professionally Used Software: Ethereum Enterprise Alliance; Blockchains-as-a-Service; Initial Coin Offering (ICO).

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' applications such as Secure medical data, Cross-border payments, Real-time IoT operating systems, Personal identity security, Anti-money laundering tracking system, Supply chain and logistics monitoring, Voting mechanism.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment:

Assignment 1: Present a case study on blockchain and cryptocurrency that has been in public domain in recent times.

Assignment 2: Present a case study on Legal context and implications for financial crime, money laundering and tax evasion.

Text Book(s):

4. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
5. Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, "Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger", Packt Publishing Limited, 2018.

Reference(s):

Reference Book(s):

44. Andreas M. Antonopoulos , "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly Media Inc, 2015
45. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.

Online Resources (e-books, notes, ppts, video lectures etc.):

61. Prof. Sandeep Shukla's NPTEL Lecture Notes and Videos on "Introduction to Blockchain Technology and Applications", (IIT Kanpur): https://onlinecourses.nptel.ac.in/noc20_cs01/preview
62. Prof. Sandip Chakraborty, Prof. Shamik Sural NPTEL Lecture Notes and Videos on "Blockchain and its Applications", (IIT Kharagpur): https://onlinecourses.nptel.ac.in/noc22_cs44/preview
63. Prof. Gary Gensler's MIT OpenCourseWare on "Blockchain and Money": https://www.youtube.com/watch?v=EH6vE97qIP4
64. Simplilearn's Blockchain & Cryptocurrency Course for 2022: https://www.youtube.com/watch?v=-wVscqiUfJs

E-content:

64. Zheng, Zibin, Shaoan Xie, Hong-Ning Dai, Xiangping Chen, and Huaimin Wang. "Blockchain challenges and opportunities: A survey." *International journal of web and grid services* 14, no. 4 (2018): 352-375. https://allquantor.at/blockchainbib/pdf/zheng2018blockchain.pdf
65. Miraz, Mahdi H., and Maaruf Ali. "Applications of blockchain technology beyond cryptocurrency." *arXiv preprint arXiv:1801.03528* (2018). https://arxiv.org/ftp/arxiv/papers/1801/1801.03528.pdf
66. Xu, Lei, Lin Chen, Zhimin Gao, Larry Carranco, Xinxin Fan, Nolan Shah, Nour Diallo, and Weidong Shi. "Supporting blockchain-based cryptocurrency mobile payment with smart devices." *IEEE Consumer Electronics Magazine* 9, no. 2 (2020): 26-33. https://ieeexplore.ieee.org/abstract/document/8977822
67. Monrat, Ahmed Afif, Olov Schelén, and Karl Andersson. "A survey of blockchain from the perspectives of applications, challenges, and opportunities." *IEEE Access* 7 (2019): 117134-117151. https://ieeexplore.ieee.org/abstract/document/8805074
68. ur Rehman, Muhammad Habib, Khaled Salah, Ernesto Damiani, and Davor Svetinovic. "Trust in blockchain cryptocurrency ecosystem." *IEEE Transactions on Engineering Management* 67, no. 4 (2019): 1196-1212. https://ieeexplore.ieee.org/abstract/document/8892660
69. Bodkhe, Umesh, Sudeep Tanwar, Karan Parekh, Pimal Khanpara, Sudhanshu Tyagi, Neeraj Kumar, and Mamoun Alazab. "Blockchain for industry 4.0: A comprehensive review." *IEEE Access* 8 (2020): 79764-79800. https://ieeexplore.ieee.org/abstract/document/9069885

Topics related to development of "EMPLOYABILITY": Blockchain, Bitcoin, Ethereum, Cryptocurrency mining.

Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": To minimize fraud and money laundering etc.

Catalogue prepared by	Dr. Rajiv Ranjan Singh & Dr. Sreenivasappa B V
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Open Electives

Course Code: **ECE1003**	**Course Title: Fundamentals of Electronics** **Type of Course: Open Elective**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**Nil**					
Anti-requisites						
Course Description	The purpose of this course is to introduce the students to Electronics and Communication Systems. The course is conceptual and is an introductory level course. It is primarily intended at Non-Electronics background students and introduces the basic concepts of semiconductor devices and electronics engineering.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Fundamentals of Electronics and attain SKILL DEVELOPMENT through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Describe the significance of electronic devices, specifically diodes 2. Explain the operating principles of BJT and its applications. 3. Summarize the concepts of number system, Boolean laws and logic gates. 4. Discuss the basic concepts of Microprocessors and Communication systems.					
Course Content:						
Module 1	**Basic Electronic Components and applications**	Quizzes and assignments	Memory Recall based Quizzes and assignments	**10SESSIONS**		
Topics: Classification of materials into Resistors, Conductors, Insulators, Ohm's law, Kirchhoff's laws. Semiconductor materials: Intrinsic and extrinsic. Bands and Bonds. The p-n junction diode, Characteristics and Parameters, Diode ideal approximation (only one approximation) DC load line, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge Rectifier(only operation, no derivations)Rectifier with capacitor Filter operation(only qualitative waveforms, no derivations), Zener and Avalanche breakdown.						
Module 2	**Bipolar Junction Transistors**	Quizzes and assignments	Memory Recall based Quizzes	**10 SESSIONS**		
Topics: BJT Construction, BJT operation, BJT Symbol, Voltages and Currents, Common Base, Common Emitter and Common Collector configurations. Alpha, Beta, Gamma and current conversions.CE Characteristics in active, saturation and cutoff. DC Load line concept. Concept of biasing and feedback for stabilization(only operation, no derivations)						
Module 3	**Digital Electronics**	Quizzes and assignments	Programming and Simulation Task	**11 SESSIONS**		
Topics: Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, and Binary to decimal, Hexadecimal to and from Binary, Complement of Binary						

Numbers(no subtractions)

Boolean Algebra Theorems, De Morgan's theorems. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, NAND Gate, NOR Gate, X-NOR Gate, SOP AND-OR implementation, NAND-NAND Implementation.

Module 4	**Introduction to Microprocessor and communication systems**	Quizzes and assignments	Memory Recall Quizzes and assignments	**9 SESSIONS**

INTEL 8085 MICROPROCESSOR: Basic Architecture and features of 8085 Microprocessor. Flags.
COMMUNICATION SYSTEM: Block diagram of communication system, Modulation: Definition of Modulation, Need of Modulation, Types of Modulation: Amplitude Modulation and Frequency Modulation (Waveforms only).

Textbook(s):

T1: John Hiley, Keith Brown and Ian McKenzie Smith, *"Hughes Electrical and Electronic Technology",* Pearson, 12th Edition

References

R1: D.P. Kothari, I. J. Nagrath, *"Basic Electronics",* McGraw Hill Education, 1st Edition

R2: Rajendra Prasad, *"Fundamentals of Electronics Engineering",* Cengane Learning, 3rd Edition

Class Notes (CN) and Video Lectures

1. Video lectures on "BASIC ELECTRONICS" by Prof. Dr. Chitralekha Mahanta, Department of Electronics and communication Engineering, IIT Guwahati": https://nptel.ac.in/courses/117/103/117103063/

2. Lecture Series on " Useful Laws in Basic Electronics" by Prof. T.S.Natarajan, Department of physics, IIT Madras: https://www.youtube.com/watch?v=vfVVF58FtCc

3. Lecture Series on "Introduction to Bipolar Junction Transistors BJT " by All About Electronics Youtube Channel:

https://www.youtube.com/watch?v=-VwPSDQmdjM&list=PLwjK_iyK4LLDoFG8FeiKAr3IStRkPSxqq

4. Lecture Series on " PN Junction Diode " by All About Electronics Youtube Channel:

https://www.youtube.com/watch?v=USrY0JspDEg

E-content:

1. Ali HabebAseeri ,Fouzeyah Rajab Ali, "Bipolar Junction Transistor as a Switch", IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 13, Issue 1 Ver. I (Jan. – Feb. 2018), PP 52-57. [PDF] Bipolar Junction Transistor as a Switch | Semantic Scholar

2. Osama S. HAMAD, Othman SIDEK, MahfoozurREHMAN,Kamarulazizi IBRAHIM, Magdy H. MOURAD, "FABRICATION PROCESS OF SILICON-ON-INSULATOR AND LATER BIPOLAR TRANSISTORS", Journal of Annals of Faculty of Engineering Hunedoara-Journal of Engineering; TOME-VII,2009, ISSN 1584-2665. Osama S. Hamad's research works | Universiti Sains Malaysia, George Town (USM) and other places (researchgate.net)

3. Amos, S. W. Principles of transistor circuits: Introduction to the design of amplifiers, receivers, and digital circuits. (6th ed.). London: Butterworths, 1981: Principles of Transistor Circuits: Introduction to the Design of Amplifiers ... - S W Amos, Mike James - Google Books

4. DipayanBhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;KazuyukiMurase, "An encoding technique for design and optimization of combinational logic circuit"2010, 13th International Conference on Computer and Information Technology (ICCIT). An encoding technique for design and optimization of combinational logic circuit | Semantic Scholar , An encoding technique for design and optimization of combinational logic circuit | Request PDF (researchgate.net)
5. A. Matrosova and V. Provkin, "Applying Incompletely Specified Boolean Functions for Patch Circuit Generation," 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-4,
doi: 10.1109/EWDTS52692.2021.9581029.Applying Incompletely Specified Boolean Functions for Patch Circuit Generation | IEEE Conference Publication | IEEE Xplore

Topics relevant to "SKILL DEVELOPMENT": Rectifiers, BJT operation, Boolean Algebra, Number Systems, Microprocessor, Block diagram of communication system, Modulation for **Skill Development** through **Participative Learning** techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Safinaz S
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

<table>
<tr><td>Course Code:
ECE1004</td><td colspan="4">Course Title: Microprocessor based Systems

Type of Course: Open Elective</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="9"></td></tr>
<tr><td>Course Description</td><td colspan="9">This course provides fundamental concepts of microprocessor-based systems. It also imparts knowledge of both hardware and software, culminating in a system design that can be used in real-world applications. The course highlights assembly language programs as well as hardware interconnections for commonly used applications.</td></tr>
<tr><td>Course Objective</td><td colspan="9">The objective of the course is to familiarize the learners with the concepts of Microprocessor based Systems and attain ENTREPRENEURIAL SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
(1) Discuss the architecture and working principles of 8086 microprocessor.
(2) Develop solutions using assembly language programming using coding and debugging skills.
(3) Apply methods to interface memories and input/output devices to the microprocessor.
(4) Deploy techniques to design a microprocessor-based system by interfacing programmable peripheral devices like 8255, 8254 etc.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="3">Fundamentals of Digital Systems and Microprocessors</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">10Sessions</td></tr>
<tr><td colspan="10">Topics:
A quick review of Digital Systems – Number Systems, Logic Gates, Some important digital circuits like Multiplexers, Decoders, Flip-Flops / Latches and Registers.

Intel’s 8086 Microprocessor: Architecture, Programming Model, Pin Diagram, Min/Max Mode, Timing Diagram, Instruction cycle, Machine Cycle and T-states.</td></tr>
<tr><td>Module 2</td><td colspan="3">8086 Instruction Sets and Assembly Language Programming</td><td>Assignment / Quiz</td><td colspan="3">Programming and Simulation task</td><td colspan="2">12 Sessions</td></tr>
<tr><td colspan="10">Topics:
Addressing Modes: Register Addressing, Immediate Addressing, Direct Addressing, Register Indirect Addressing, Base-Plus-Index Addressing, Register Relative Addressing, Base Relative-Plus-Index Addressing, Memory Addressing Mode.

Instruction Sets: Data movement instructions, Program control instructions, Arithmetic and Logical Instructions, Stack Instructions, String Instructions. Assembly Language Programs.</td></tr>
<tr><td>Module 3</td><td colspan="3">Introduction to</td><td>Assignment</td><td colspan="3">Memory Interfacing</td><td colspan="2">10</td></tr>
</table>

	Interfacing Techniques		Task and Analysis	**Sessions**
Topics: Review of some assembly programming concepts, I/O Interfacing: LEDs and toggle-switches as example, Memory Interfacing, Interrupts, Input/Output techniques: CPU initiated unconditional and conditional I/O transfer, device-initiated interrupt I/O transfer.				
Module 4	Interfacing of Peripheral Devices with 8086	Assignment	System Design Task and Analysis	**09 Sessions**
Topics: Peripheral Devices, Programmable Peripheral Interface (Intel 8255A, pin configuration, internal structure of a port bit, modes of operation, bit SET/RESET feature), Programmable Interval timer (Intel 8254): pin configuration, internal block diagram of counter and modes of operation and counter read methods, READ-BACK command of Intel 8254, Microprocessor based system design.				
Textbook(s): **1. Brey B. B., "The Intel Microprocessors", Pearson, Eighth Edition.**				

References

Reference Book(s)

1. Hall Douglas V. and Rao S. S. S. P., "Microprocessor and Interfacing", McGraw Hill Education.

2. Das Lyla B., "The x86 Microprocessors", Pearson.

3.Raj Kamal., "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson.

4. Microprocessor Programming and Interfacing Laboratory Manual

Online Resources (e-books, notes, ppts, video lectures etc.):

1. The Intel Microprocessors: Architecture Programming and Interfacing book by Barry B. Brey, Eighth Edition <https://userpages.umbc.edu/~squire/intel_book.pdf>
2. Microprocessors Lectures adapted from slides and the textbook materials of Dr. Kip Irvine <https://www.philadelphia.edu.jo/academics/qhamarsheh/page.php?id=13>
3. Documentation for Emu8086 <https://www.philadelphia.edu.jo/academics/qhamarsheh/uploads/emu8086.pdf>
4. Microprocessors and Interfacing NPTEL Video Lectures <https://nptel.ac.in/courses/108/103/108103157/>
5. x86 Assembly Language Programming <https://cs.lmu.edu/~ray/notes/x86assembly/>

E-content:

1. Faggin, Federico, Marcian E. Hoff, Stanley Mazor, and Masatoshi Shima. "The History of the 4004." *Ieee Micro*, vol. 16, no. 6 (1996), pp. 10-20. https://www3.nd.edu/~kogge/courses/cse40462-VLSI-fa18/www/Public/other/history_of_4004.pdf
2. Brooks, David M., Pradip Bose, Stanley E. Schuster, Hans Jacobson, Prabhakar N. Kudva, AlperBuyuktosunoglu, John Wellman, Victor Zyuban, Manish Gupta, and Peter W. Cook. "Power-aware microarchitecture: Design and modeling challenges for next-generation microprocessors." IEEE Micro, vol. 20, no. 6 (2000), pp. 26-44. https://dominoweb.draco.res.ibm.com/reports/rc21876.pdf
3. Sima, Dezsö. "Decisive aspects in the evolution of microprocessors." Proceedings of

<table>
<tr><td colspan="2">the IEEE, vol. 92, no. 12 (2004), pp. 1896-1926. https://ieeexplore.ieee.org/document/1360164
4. Borkar, Shekhar, and Andrew A. Chien. "The future of microprocessors." Communications of the ACM, vol. 54, no. 5 (2011), pp. 67-77. https://www.eng.auburn.edu/~agrawvd/COURSE/READING/ARCH/Future_of_microP_Borkar.pdf</td></tr>
<tr><td colspan="2">Topics relevant to “ENTREPRENEURIAL SKILLS”: Assembly Language Programming concepts, Memory & I/O Interfacing, Interrupts and Programmable Peripheral ICs for developing Entrepreneurial Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.</td></tr>
<tr><td>Catalogue prepared by</td><td>Mrs. Priyanka Ray</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 19th BOS held on 06/07/2024</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 24th , Dated 03/08/2024</td></tr>
</table>

Course Code: ECE3089	**Course Title: Artificial Neural Networks** **Type of Course: Open Elective**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**NA**					
Anti-requisites	Nil					
Course Description	The purpose of this course is to introduce the students to Machine learning and decision systems. The course is both conceptual and analytical and develops critical design skills by introducing the concept of "Thinking by machines". We talk of gathering and processing of knowledge, and classifiers and controllers based on approximate reasoning.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Artificial Neural Networks and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques					
Course Outcomes	**On successful completion of this course the students shall be able to:** i. Distinguish Learning paradigms and Learning Algorithms for a simple neural network. ii. Explain the implementation of linearly separable/ Non- linearly separable problems with SLP/ MLP. iii. Illustrate the implementation of non-linearly separable problems with MLP. iv. Discuss various real time problems and their solutions using ANN.					
Course Content:						
Module 1	**Introduction To Artificial Neural Networks**	Assignments	Assignments	**09 SESSIONS**		
Topics: **Module: 1:** Natural and artificial neuron, Models Of A Neuron, simple real world learning problem like a two year baby learning sweet milk versus fire. Neural Networks- Associated Graphs And Feedback, Network Architectures And Knowledge Representation, 4 Rules of Knowledge. Learning Processes, Learning Algorithms and learning Paradigms. ANNs						
Module 2	**Single layer perceptron for linearly separable problems**	Quizzes and assignments	Quizzes and assignments	**10 SESSIONS**		
Topics: Single Layer Feed forward N/W, Multilayer Feed Forward N/W, Rosenblatt's Perceptron, Error correction algorithm, Hebbian learning algorithm and Perceptron convergence algorithm. Introduction to Digital Logic gates. Implementation of learning with different algorithms for linearly separable digital logic gates. Derivation of perceptron convergence theorem and Introduction to LMS algorithm. Concept and Domain of MLP for non-linearly separable problems where SLP is unsuitable (no derivations).						
Module 3	**Multilayer perceptron**	Quizzes and assignments	Quizzes and assignments	**10 SESSIONS**		
Topics: The back propagation algorithm, Forward path for function computation, back ward path for error computation and synaptic adjustments, X-OR Problem and why it cannot be implemented with SLP, Heuristics for making back propagation perform better.						

Module 4	**Applications of ANN**	Quiz	Quizzes and assignments	**11 SESSIONS**

Topics:**Applications**: Implementing Artificial Neural Network training process in MATLAB and Python, Introduction to CNN, Implementation of classification task on MATLAB, Implementation of image recognition using CNN on python, Demonstration of real time projects based on image classification on Teachables

List of Laboratory Tasks:

Targeted Application & Tools that can be used :

JOBS- AI & ML ENGINEERS IN SOFTWARE INDUSTRY, Data Scientist, Machine Learning Engineer, Research Scientist, Business Intelligence Developer, AI Data Analyst, Big data engineering, Robotics Scientist, AI engineer

TOOLS – PYTHON, MATLAB, JAVA**.**

Project work/Assignment:

1. Sample Project works - Iris Flowers Classification Project, MNIST Digit Classification Machine Learning Project, Stock Price Prediction using Machine Learning, Wine Quality Test Project, Music Genre Classification Machine Learning Project, Handwritten Character Recognition

2. **Sample Assignments –**

i. You went to an agriculture farm which cultivates vegetables. Identify any three problems which can be solved by machine learning and mention the steps of database preparation and training the models.

ii. Implement the perceptron model of a two-input XOR gate in MATLAB/ Python and verify the structure using the truth table.

iii. Please visit the college library or e-resource and find the below Journal and submit the report for the following paper (Attach the title of the journal and the paper)

iv. A single layer n/n is given with two input values [x1 x2]=[0.05 0.10]; and initial weights as w1=0.15 w2= 0.20 w3= 0.25 w4= 0.30 w5=0.40 w6=0.45 w7=0.50 w8=0.55; bias value as b1=0.35 b2=0.60; target value T1=0.01, T2=0.99. Show the steps for both forward and backward pass at the output layer.

3. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

Text Book(s):

1. Simon Haykin, "*Neural Networks and Learning Machines*", Pearson.

Reference Book(s)

1. C. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press.
2. K. Mehrotra, C. Mohan, and S. Ranka, "*Elements of Artificial Neural Networks"*, MIT Press
3. Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition) by Eric Matthes

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Introduction to ANN (NPTEL) - https://nptel.ac.in/courses/117/105/117105084/
2. Artificial Intelligence Courses (Udemy) - https://www.udemy.com/topic/artificial-intelligence/
3. Supervised Machine Learning: Regression and Classification by Dr. Andrew Ng (Coursera) - https://www.coursera.org/learn/machine-learning

E-content:

1. Ciregan, D., Meier, U., & Schmidhuber, J. (2012, June). Multi-column deep neural networks for image classification. In 2012 IEEE conference on computer vision and pattern recognition (pp. 3642-3649). IEEE. - https://ieeexplore.ieee.org/abstract/document/6248110

2. W. Lin and G. Chen, "Large Memory Capacity in Chaotic Artificial Neural Networks: A View of the Anti-Integrable Limit," in *IEEE Transactions on Neural Networks*, vol. 20, no. 8, pp. 1340-1351, Aug. 2009, doi: 10.1109/TNN.2009.2024148. - https://ieeexplore.ieee.org/document/5166455

3. K. B. Lee and H. S. Shin, "An Application of a Deep Learning Algorithm for Automatic Detection of Unexpected Accidents Under Bad CCTV Monitoring Conditions in Tunnels," *2019 International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*, 2019, pp. 7-11, doi: 10.1109/Deep-ML.2019.00010. https://ieeexplore.ieee.org/document/8876906
4. D. Goularas and S. Kamis, "Evaluation of Deep Learning Techniques in Sentiment Analysis from Twitter Data," *2019 International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*, 2019, pp. 12-17, doi: 10.1109/Deep-ML.2019.00011. https://ieeexplore.ieee.org/document/8876896

Topics relevant to "ENTREPRENEURIAL SKILLS": Applications of ANN for developing Entrepreneurial Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms Anupama S, Mr. Arvind Kumar
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3097	**Course Title: Smart Electronics in Agriculture** **Type of Course: Open Elective**	**L- T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts assembly programming and embedded C, Understanding of interfacing Memory and peripherals.					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to introduce students to smart and precision based agriculture is technology methods. Electronics has played a major role in developing the economy of the nation. India is the farmers land and agro based business are existing in India from long time. This course is designed to introduce a new approach of engineering where the modern sensors and embedded solutions along with mechanical and traditional equipment work hand in hand to increase the yield of the farmer. Electronics technologies and Industry 4.0 which is transforming the industry by integrating modern technology with the help of sensors, computational processes and communication technologies. The course inculcates critical thinking skill within students to develop and design a complete solution using program and interfacing hardware to provide wireless or wired smart solutions. The nature of course being comprehensive as well as application based, covers number of quizzes, simulations and interfacing practical's which helps to enhance students' abilities to become an IoT Application Designer					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Explain the Components and Process of Agriculture. (2) Demonstrate the electronics smart sensors and embedded systems. (3) Employ techniques for cloud based application in agriculture.					
Course Content:						
Module 1	Component of Agriculture	QUIZ	Comprehension level Quiz	**12 classes**		
Topics: Indian Agriculture and green revolution. Methods of agriculture and role of technology in agriculture. Role of technology in fertilizers and pesticide and irrigation management in modern agriculture, integrating big data Practices in Agriculture, Internet of things (IoT) and data analytics in smart agriculture: Functional framework for IoT-based agricultural system Functional framework for edge-based agricultural system Benefits and challenges. IoT fundamentals and its applications devices for smart agriculture. Precision agriculture Hydroponics.						
Module 2	Smart electronic for Agriculture	Case Study	Sensor and Embedded system	**15 classes**		
Topics: Sensors and actuator for agriculture, smart embedded systems, understanding Arduino Boards, Programming and Interfacing. Selection of Embedded Platform. IoT technology Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud. Iot Accessing technology- IEEE 802.15.1,IPV4 and IPV6 Addressing IoT nodes, IoT Edge, MQTT, AMQP, COAP Interfacing RFID and Sensors						

and Actuators through Protocols

Module 3	Cloud Based IoT Applications	Mini Project	System Design Task and Analysis	**12 Classes**

Topics:
The Internet of Things in agriculture for sustainable rural development. Internet of Things (IoT) in agriculture toward urban greening. Smart e-agriculture monitoring systems , smart agriculture using renewable energy and AI-powered IoT. Surveying smart farming for smart cities, Farm Automation. A fog computing-based IoT framework for prediction of crop disease using big data analytics Agribots: A gateway to the next revolution in agriculture**,** Transforming IoT in aquaculture: A cloud solution

Targeted Application & Tools that can be used:
Important Applications range from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IOT
Professionally Used Software: Kiel, C and Python

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4.Assignment:Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples.

Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate.

Assignment: 2] Design a IOT based application for

A. Climate condition monitoring and automated systems
B. Internet of Things on sustainable aquaculture system
C. IoT-based monitoring system for freshwater fish farming: Analysis and design
D. Design a IoT based agricultural system for optimal management

Textbook(s):

1. Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu Kumar Pani "AI, Edge and IoT-based Smart Agriculture "1st Edition November 10, 2021
2. Prasant Kumar Pattnaik, Raghvendra Kumar, S. N. Panda, Souvik Pal " IoT and Analytics for Agriculture"2020

References

1.. Arshdeep Bagha & Vijay Madisetti, " Internet of Things a Hands on Approach"
2. Adrian McEwen & Hakim Cassimally "Designing the Internet of Things".
3.IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

E-Content:-

1. Vijaya Saraswathi R, Sridharani R,Saranya chowdary P ,Nikhil K Smart Farming: The IoT based Future Agriculture 2022 4th International Conference on Smart Systems and Inventive Technology (ICSSIT) 25 February 2022 Smart Farming: The IoT based Future Agriculture | IEEE Conference Publication | IEEE Xplore

2. Cheena Sharma and Naveen Kumar Gondhi 2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU) 23-24 Feb. 2018Communication Protocol Stack for Constrained IoT Systems.https://ieeexplore.ieee.org/document/8519904/authors#authors
3. Bertha Mazon-Olivo and Alberto Pan IEEE Latin America Transactions 1 Jan.-2022 Internet of Things: State-of-the-art, Computing Paradigms and Reference Architectures.https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9662165
4. Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International Conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis. https://ieeexplore.ieee.org/document/8439638
5. Introduction To Internet Of Things - Course (nptel.ac.in)

Topics relevant to development of "Emplobility": The Internet of Things in agriculture for sustainable rural development.
Internet of Things (IoT) in agriculture toward urban greening. Topics relevant to development of "Entrepreneurship" : Smart e-agriculture monitoring systems , AI-powered IoT. Surveying smart farming for smart cities, Farm Automation

Catalogue prepared by	Ms.Renuka Bhagwat
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3098	**Course Title: Environment Monitoring system** **Type of Course: Open Elective**		**L- T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	Internet of Things					
Course Description	This course provides fundamental concepts of various environment monitoring eco systems. It provide students with deep knowledge of sensors and data acquisition systems to monitor atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems. The course also provides students with deep knowledge of importance of single board computers and data loggers.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe the concepts of continuous real time monitoring systems with Internet of Things. (2) Understand constraints and opportunities of single board computers. (3) Describe the various setup to monitor and measure the data collected from environment. (4) Able to design and perform experiments on sensors and develop the projects based on the customer needs.					
Course Content:						
Module 1	Introduction	Quiz	Memory Recall based Quizzes	**10 Sessions**		
Topics: Environmental systems,Echo systems and planet earth.Human Interaction with the environment, from measuring to knowing, continuous real time monitoring,data management and World Wide Web. Sampling,Ground based,airborne and spaceborne systems.						
Module 2	From Sensors to systems.	Assignment / Quiz	Memory Interfacing Task and Analysis	**12 Sessions**		
Topics: Sensors and transducers: Principles of electrical quantities, circuits,sensor specifications, from sensors to transducers, case studies:from light sensors to a light transducers, from thermistor to temperature tranducers,temperature transducres for air,soil and water.Thermocouples,using thermocouples.						
Module 3	Data Acquisition systems	Assignment	Memory Interfacing Task and Analysis	**10 Sessions**		
Topics: Introduction to data loggers, applications in environment monitoring, analog channels, Real time clock, communications with datalogger,RS-232 standard, single board computers, ARM Architectures						
Module 4	Applications	Assignment	Programming and	**09**		

			Simulation task.	**Sessions**

Topics: Atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems

Targeted Application & Tools that can be used:

Application Area:

Environmental monitoring applications are essential to generating information about the quality of the environment around us, including whether it is improving, worsening, or staying the same. The kind of data environmental monitoring applications produce assist in decision making, both by governments and private actors. Of course policymakers need accurate, reliable information from applied environmental monitoring, and so do municipal engineers, public health experts, first responders dealing with environmental emergencies, farmers, foresters, hunters, and recreational wilderness users all rely upon these applications.

Professionally Used Software: students can use open SOURCE Softwares like Keil, Python IDLE etc.

Project work/Assignment:

1. Mini Projects: At the end of the course students will be assigned a project work on solving many environmental monitoring issues in real time.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a group presentation, where the students will be given a project on wearable device applications. They will have to explain/demonstrate the working and discuss the applications for the same.

Textbook(s):

1. Miguel. F Acevedo editors. "Real time Environment monitoring systems" Institution of Engineering and Technology, Taylor and Francis publication, First edition.

References

Reference Book(s)

1. Janick F Artiola editors. "Environmental Monitoring and characterization". Elsevier academic press, second edition,2004.
2. Subash Chandra. "Smart sensing for agriculture and environmental monitoring ". Springer publisher,second edition,2010.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Ambient assisted living and enhanced living environments: principles, technologies and control Ciprian Dobre, First Edition < https://www.elsevier.com/books/ambient-assisted-living-and-enhanced-living-environments/dobre/978-0-12-805195-5 >
2. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088 >
3. Case studies on Wearable technology< https://www.hticiitm.org/wearables>

E-content:

1. Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ISBN-13: 978-1882417087.
2. Standard Methods for the Examination of Water and Wastewater, 21st Ed. 2005 APHA, AWWA. https://www.worldcat.org/title/standard-methods-for-the-examination-of-water-and-wastewater/oclc/156744115.
3. R. Maheswar, P. Jayarajan, S. Vimalraj, G. Sivagnanam, V. Sivasankaran and I. S. Amiri, "Energy Efficient Real Time Environmental Monitoring System Using Buffer Management Protocol," 2018, pp. 1-5, doi: 10.1109/ICCCNT.2018.8494144. https://ieeexplore.ieee.org/document/8494144.
4. F. Sánchez-Rosario *et al*., "A low consumption real time environmental monitoring system for smart cities based on ZigBee wireless sensor network," *2015*, pp. 702-

707, doi: 10.1109/IWCMC.2015.7289169. https://ieeexplore.ieee.org/document/7289169	
Topics relevant to development of "SKILL": System design for environmental monitoring systems.	
Catalogue prepared by	Dr. Divya Rani
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: **ECE3102**	**Course Title: Consumer Electronics** **Type of Course: Open Elective**		**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basics of Electronics					
Anti-requisites	**NIL**					
Course Description	This course is designed to enhance the knowledge, skills and attitude in performing testing assembling/disassembling of electronic components, maintaining and repairing audio/video products and systems, terminating/connecting electrical & electronics circuit and maintaining and repairing electrically-controlled domestic appliance .It also covers Computer operation with internet browsing, industry control system, Color TV, LCD, LED,CD VCD, DVD, IPS, UPS, cellular phone, House hold appliance and using specialized equipment repair and commissioning of consumer electronic products and systems.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques					
Course Outcomes	**On successful completion of this course the students shall be able to:** [1] Identify the devices and system functions [2] Classify the components in electronics [3] Demonstrate and explain the house hold appliances					
Course Content:						
Module 1	**Audio Fundamentals, Devices & Systems**	Assignment/ Quiz	Memory Recall based Quizzes	**15 Sessions**		
Topics: Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types. Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types.						
Module 2	**Television Fundamentals**	Assignment/ Quiz	Real time Application Project	**15 Sessions**		
Topics: Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution, Composite video signal, Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance, Different types of TV camera, Transmission standards. PAL-D colour TV receiver, Digital TVs:- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver, Video interface, Digital Video, SDI, HDMI Multimedia Interface , Digital Video Interface, CD and DVD player.						

Module 3	**Home / Office Appliances**	Assignment/ Quiz	Memory Recall based Quizzes	**10 Sessions**

Home Appliances: Inverter, Microwave oven, Domestic Refrigerator, Controls in Refrigerator, Room Air Conditioning.
Office Appliances : Calculator, Facsimile (FAX) and Pager.

Targeted Application & Tools that can be used:
Consumer Electronics appear in a variety of application in repairing the electrical, electronic components and devices, repair of consumer house hold appliances
Professionally Used Software: Multisim

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based on consumer electronics. Students will be submitting a report on the same which will include in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
4. Project Assignments:
Consumer electronic products are invariably covered by a 'Manufacturer's Warranty' which offers the purchaser some protection against detective workmanship and component failure during a limited term.
Assignment 1: Device control using Smart Phone's Bluetooth
Assignment 2: Stereophonic Acoustic Echo Suppression for Speech Interfaces for Intelligent TV Applications.

Text Book(s):

1. Bali.S.P, "*Consumer Electronics*", Pearson Education India,2010 , latest edition

Reference(s):

Reference Book(s):

R1 Bali R and Bali S.P, "A*udio video systems : principle practices & troubleshooting*", Khanna Book Publishing Co. (P) Ltd., 2010Delhi , India, latest edition

R2 Gulati R.R., "*Modern Television practices*", New Age International Publication (P) Ltd. New Delhi Year 2011, latest edition.

R3 Gupta R.G. *"Audio video systems",* Tata Mc graw Hill, New Delhi, India 2010, latest editio

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://nptel.ac.in/courses/117108140
2. https://en.wikipedia.org/wiki/Consumer_electronics

E-content:

1. H. Hoang, S. Lee, Y. Kim, Y. Choi and F. Bien, "An adaptive technique to improve wireless power transfer for consumer electronics," in IEEE Transactions on Consumer Electronics, vol. 58, no. 2, pp. 327-332, May 2012, doi: 10.1109/TCE.2012.6227430.

2. L. Morra, S. P. Mohanty and F. Lamberti, "Artificial Intelligence in Consumer Electronics," in IEEE Consumer Electronics Magazine, vol. 9, no. 3, pp. 46-47, 1 May 2020, doi: 10.1109/MCE.2019.2962163. https://ieeexplore.ieee.org/abstract/document/9055488

3. F. Pieri, C. Zambelli, A. Nannini, P. Olivo and S. Saponara, "Is Consumer Electronics Redesigning Our Cars?: Challenges of Integrated Technologies for Sensing, Computing, and Storage," in IEEE Consumer Electronics Magazine, vol. 7, no. 5, pp. 8-17, Sept. 2018, doi: 10.1109/MCE.2017.2771515.

Topics relevant to the: "FOUNDATION SKILLS", Television fundamentals with their applications. Topics relevant to the:" EMPLOYABILITY", Home / Office Appliances .	
Catalogue prepared by	
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3103	**Course Title: Product Design of Electronic Equipment** **Type of Course: Open Elective**		**L- T-P-C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	NIL						
Anti-requisites	NIL						
Course Description	The purpose of this course is to give the students the opportunity to improve their design abilities for some well-known consumer electrical goods. Basic circuit configurations for many different electronic goods are covered throughout the course. By taking into account their electrical, mechanical, ergonomic, and aesthetic design aspects, the students will be able to design and develop various electronic components. The course's thoroughness includes a variety of tests, computer-aided design-based tools, and mockup-based projects that help students develop their talents to work independently as product design engineers.						
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING technique for designing various electronic products						
Course Outcomes	On successful completion of this course the students shall be able to: (1) Outline various electronic products and their design considerations. (2) Discuss PCB design and fabrication flow.. (3) Report ergonomic, aesthetic and packaging requirements of electronic products. (4) Discover safety and reliability issues and compliance requirement in electronic products design.						
Course Content:							
Module 1	**Overview of Electronic Products and Product Design Considerations**	Quiz	Memory Recall based Quizzes	**10 Classes**			
Topics: Audio Systems; Video Systems and; Domestic & Consumer; Air-conditioners and Refrigerators; Computers office Systems; Telephone & Mobile Radio Systems.							
Module 2	**PCB Design and Manufacturing**	Assignment / Quiz	Programming and Simulation task	**12 Classes**			
Topics: Power Supply Design – Basic circuit configurations, Regulators, Switching Regulators, Switch Mode Power Supply, PWM Control methods; CAD Tools for PCB Design – Design Rules, Schematic, Simulation, Netlist Import, Place and Route, Advance PCBs; PCB Fabrication Process; Electromagnetic Interference (EMI) – EMC and EMI, EMI Reduction and Shielding.							
Module 3	**Ergonomics and Packaging for Electronic Products**	Assignment	Mock up Design and Analysis Tasks	**10 Classes**			
Topics: Ergonomics and Aesthetics in Electronic Product Design – Overview of Ergonomics and Aesthetics in for Electronic Products, issues in placement and integration various electronic components; Packaging, Enclosures and Cooling of Electronic Systems; 3D Printing and Computer Aided Design.							
Module 4	**Product Safety and**	Assignment	System Design	**07**			

	Reliability		Analysis	Classes

Topics:
Product safety and reliability issues; System Reliability – MTTF, MTBF, MTTR etc. Maintainability, Faults and their analysis; Standards related to electrical safety and fire hazards, Design techniques for ESD, RF interference and immunity, Line current harmonics and mains voltage surge.

Targeted Application & Tools that can be used:
Application Area is electronic products and their appearance w.r.t. ergonomics and aesthetic leading to design of various consumer electronic devices and systems.
Professionally Used Software: Matlab / Python / LabVIEW / ORCAD

Project work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' product design design case studies. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. and/or a mock-up model in appropriate format.
2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. <https://presiuniv.knimbus.com/user#/home >.
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Project Assignment: Carry out various design and analysis task for various consumer electronics products.
Assignment: 1] Simulate and design the layout of an audio amplifier PCB..
Assignment 2: Prepare a mockup model of an electronic product by considering ergonomic and aesthetic issues in mind (e.g. a new mouse, a new table lamp, an audio device etc.)

Textbook(s):

1. Bali, S. P. *Consumer Electronics*. Pearson Education India, 2007**.**
2. Mitzner, Kraig. *Complete PCB design using OrCad capture and layout*. Elsevier, 2011.

Reference(s):
Reference Book(s):

1. Mitzner, Kraig. *Complete PCB design using OrCad capture and layout*. Elsevier, 2011.
2. Reis, Ronald A. "Electronic project design and fabrication." (1989).
3. Bagad, V. S. *Electronics Product Design*. Technical Publications, 2009.
4. Ohring, Milton, and Lucian Kasprzak. *Reliability and failure of electronic materials and devices*. Academic Press, 2014.
5. O'Connor, Patrick, and Andre Kleyner. *Practical reliability engineering*. John Wiley & Sons, 2012.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Dr. Shabari Nath's NPTEL Lecture Notes and Videos on "Design of Power Electronic Converters" delivered by Paban Bujor Barua: https://www.youtube.com/watch?v=f1soGt0uNqc
2. Dr. Shantanu Bhattacharya's NPTEL Lecture Notes and Videos on "Advanced manufacturing process for micro system fabrication"(IIT Kanpur): https://www.youtube.com/watch?v=_QIVe7iFd4M
3. Prof. G. V. Mahesh's NPTEL Lecture Notes and Videos on "An Introduction to Electronics Systems Packaging", (IISc Bangalore): https://nptel.ac.in/courses/108108031
4. Prof. P. C. Pande's Lecture Notes on PCB Design (IIT Bmbay):
5. https://www.ee.iitb.ac.in/~pcpandey/courses/ee616/pcblayout_c_aug07.pdf

E-content:

1. Wallace, David R., and Mark J. Jakiela. "Automated product concept design: unifying aesthetics and engineering." *IEEE Computer graphics and applications* 13, no. 4 (1993): 66-75. https://ieeexplore.ieee.org/abstract/document/219453
2. Dahl, D. W., Chattopadhyay, A., & Gorn*, G. J. (1999). The use of visual mental imagery in new product design. Journal of Marketing Research, 36(1), 18-28. https://www.jstor.org/stable/pdf/3151912.pdf
3. Han, Sung H., Myung Hwan Yun, Jiyoung Kwahk, and Sang W. Hong. "Usability of consumer electronic products." *International journal of industrial ergonomics* 28, no. 3-4 (2001): 143-151. https://www.sciencedirect.com/science/article/abs/pii/S0169814101000257
4. Kwahk, Jiyoung, and Sung H. Han. "A methodology for evaluating the usability of audiovisual consumer electronic products." *Applied ergonomics* 33, no. 5 (2002): 419-431. https://www.sciencedirect.com/science/article/abs/pii/S0003687002000340

Topics relevant to development of "EMPLOYABILITY": Working Principles of various electronic consumer products, PCB Design.
Topics relevant to development of "ENVIRONMENT AND SUSTAINABILITY SKILLS": Types of materials and wastes produced during fabrication processes as well as discarded electronic waste.

Catalogue prepared by	Dr. Rajiv Ranjan Singh
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
Date of Approval by the Academic Council	Academic Council Meeting No. 24th , Dated 03/08/2024

Course Code: ECE3106	**Course Title: Introduction to Data Analytics** **Type of Course: Open Elective Theory**		**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Probability and Statistics					
Anti-requisites	**NIL**					
Course Description	This course presents an introduction to the concepts of data analysis, the role of a Data Analyst, and the tools that are used to perform data analytics. It will provide an understanding of the data ecosystem and the fundamentals of data analysis, such as data gathering or data mining. It also provides the knowledge required to effectively communicate data to stakeholders, and making a data driven decision.Throughout this course, students will learn the fundamentals of gathering data, and learning how to identify data sources. They will also learn how to clean, analyze, and share data with the use of visualizations and dashboard tools.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	CO1] Describe the various processes of data analytics. CO2] Manipulate data in Python. CO3] Demonstrate an ability to solve and analyze the different types of data. CO4] Identify the need of data analytics.					
Course Content:						
Module 1	Introduction to Data Analytics	Quiz/Assignment	Memory Recall based Quizzes/Assignments	**6 classes**		
Topics: Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, Data Cleaning and Preparation, Handling Missing Data, Data Transformation, String Manipulation, The Data Analysis Process, Quantitative and Qualitative Data Analysis, Data Loading, Storage, and File Formats, I/O API Tools, CSV and Textual Files, Reading Data in CSV or Text Files, Time Series data analysis						
Module 2	Introduction to the Python's World-Plotting and Visualization	Quiz/Assignment	Programming, Analysis and Visualization	**8 classes**		
Topics: Python—The Programming Language, Python 2 and Python 3, IPython, and Jupyter Notebooks, Essential Python Libraries, NumPy, pandas, matplotlib, SciPy, scikit-learn, Built-in Data Structures, Functions, and Files, The matplotlib Library, Plotting with pandas and seaborn, Other Python Visualization Tools.						
Module 3	Statistics, data, and Statistical Thinking	Assignment	Programming, Analysis and Visualization	**8 classes**		
Topics: Describing Qualitative Data, Numerical Measures of Central Tendency, using the Mean and Standard Deviation to Describe Data, Methods for Detecting Outliers: Box Plots and z-Scores, Types of Random Variables, Probability Distributions for Discrete Random Variables, Expected Values of Discrete Random Variables, The Binomial Random						

Variable, The Poisson Random Variable, Statistical inference, Bias, The method of moments, Least squares/weighted least squares, Maximum likelihood

Module 4	Machine Learning with scikit-learn	Assignment	Programming, Analysis and Visualization	**9 classes**

Topics:

The scikit-learn Library, Supervised Learning with scikit-learn, The Iris Flower Dataset, K-Nearest Neighbors Classifier, Linear Regression, The Least Square Regression, Support Vector Machines (SVMs)

Project work/Assignment:

1. Project: At the end of the course, students will be given a 'real-world' data analytics application based topic as a project. Students will be submitting a report, which will include different steps of data cleaning and preparation, plotting and visualization and Results of the analysis etc. in appropriate format.
2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
3. Assignments:
Assignment 1: Using Python programming, the students are required to analyze loan application data.
Assignment 2: Using Python programming, the students are required to analyze stock price data and perform different steps of data cleaning and preparation, plotting and visualization

Textbook

T1. Wes McKinney, "Python for Data Analysis: Data Wrangling With Pandas, Numpy, And Ipython", O'Reilly Publications, 2017
T2. Fabio Nelli, "Python Data Analytics Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language", Apress.

References

R1. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
R2. Leonard Kaufman, Peter J. Rousseeuw (1990). Finding Groups in Data: An Introduction to Cluster Analysis. "John Wiley & Sons, Inc".

Topics for Technology Enabled Learning:

1. Data Analysis with Python | Coursera, Offered by IBM
https://www.coursera.org/professional-certificates/ibm-data-analyst
2. Data Analytics with Python - NPTEL Online Courses, by Prof. A Ramesh | IIT Roorkee
https://onlinecourses.nptel.ac.in/noc21_cs45/preview

Topics relevant to development of "FOUNDATION SKILLS": Interpret the type of data analysis tools and techniques.
Topics relevant to "HUMAN VALUES &PROFESSIONAL ETHICS": Concepts of Data collection and analysis for an assignment.

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024

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Course Code: ECE3107	**Course Title : Machine Vision for Robotics** **Type of Course: Open Elective**	**L- T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**NA**					
Anti-requisites	NIL					
Course Description	The purpose of this course is to teach the principles and applications of vision system in modern manufacturing Environment. The nature of this course is analytical with practical understanding. It is also intended at introducing basic concepts to Non ECE and CSE students. The course is analytical in nature and needs fair knowledge of digital image processing. The first part of the course focuses the basics vision systems and object recognition. Further, it explores the knowledge in robot vision applications.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	**On successful completion of this course the students shall be able to:** [1] Explore various vision systems for Machines [2] Understand the image capturing and processing techniques [3] Apply the robotic operating system to Machines					
Course Content:						
Module 1	**Overview of Machine Vision in IP**	Quizzes and assignments				**12 SESSION**
Topics: Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interface- Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction- Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values.						
Module 2	**Vision algorithms and applications**	Quizzes and assignments				**12 SESSION**
Topics: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.						
Module 3	**ROBOT Vision**	Quizzes and assignments				**12 SESSION**
Topics: Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package						
Targeted Application & Tools that can be used: Application Area includes all intelligence devices like Unmanned Vehicle. The students will be able to join a profession which involves basics to high level of automation design and analysis.						

Professionally Used Software: PYTHON, MATLAB, JAVA. PyTorch, AWS cloud, Torch, Keras, TensorFlow-IBM Watson

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a real-world scenario for any application like, Drive the solution of a shape-from-shading problem at a singular point, by fitting a smooth local shape near the singular point. Students will be submitting a report which will include Design and implementation methodology.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .

3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4.Assignment 1:) Consider a flying robotic system that uses binocular stereo to obtain three dimensional information from pairs of images. Suppose that the scale of the recovered three dimensional coordinates is not known accurately because the baseline between exposure stations is not known with precision. Now suppose that two such three-dimensional models — obtained along different flight paths — are to be related. In this case, determining the absolute orientation requires that, in addition to translation and rotation, a scale factor relating the two three dimensional models be found as well.

Text Book(s):

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.
2. Damian m Lyons, "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.

References:

Reference Book

1. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition - Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
3. 3. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.
4. K. Mehrotra, C. Mohan, and S. Ranka, "*Elements of Artificial Neural Networks"*, MIT Press

Online Resources (e-books, notes, ppts, video lectures etc.):

1. 6.801 / 6.868 Machine Vision, Lecture 2 (mit.edu)
2. 6.801/6.866: Machine Vision, Lecture 8 (mit.edu)
3. 6.801/6.866: Machine Vision, Lecture 11 (mit.edu)
4. 6.801/6.866: Machine Vision, Lecture 13 (mit.edu)
5. 6.801/6.866: Machine Vision, Lecture 23 (mit.edu)
6. NPTEL - Robotics - Course (nptel.ac.in)
7. Python Machine Learning Tutorial (Data Science) - Bing video
8. E-Book 1.Machine Vision (November 1996 edition) | Open Library
9. https://presiuniv.knimbus.com/user#/home

E-Content

1. Carsten Steger, Markus Ulrich"- A Multi-view Camera Model for Line-Scan Cameras with Telecentric Lenses (springer.com)" Journal of Mathematical Imaging and Vision (2022) 64:105–130 https://doi.org/10.1007/s10851-021-01055-x
2. Carsten Steger " A Comprehensive and Versatile Camera Model for Cameras with Tilt Lenses (springer.com)" Int J Comput Vis (2017) 123:121–159 DOI 10.1007/s11263-016-0964-8
3. Markus Ulrich, Christian Wiedemann, Carsten Steger: " **CAD-Based Recognition of 3D Objects in Monocular Images"** *International Conference on Robotics and*

Automation (2009).
4. Aggarwal, M., Ahuja, N. A Pupil-Centric Model of Image Formation. International Journal of Computer Vision 48, 195–214 (2002). https://doi.org/10.1023/A:1016324132583

The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING in Robotic operating System (ROS)- installing and testing ROS camera Drivers, ROS to OpenCV

Catalogue prepared by	Dr G MUTHUPANDI
Recommended by the Board of Studies on	BOS Meeting NO: 19th BOS held on 06/07/2024
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