PRESIDENCY UNIVERSITY

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PROGRAMME REGULATIONS & CURRICULUM

2024-28

PRESIDENCY SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.TECH. - VLSI DESIGN TECHNOLOGY

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

2024-2028

BACHELOR OF TECHNOLOGY (B.Tech.) in

VLSI DESIGN TECHNOLOGY

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/2024-28

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 2024-2028.
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 2024-2028 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 2024-2025.

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

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

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

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

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

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

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

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

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

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

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

ee. *"Program Regulations" means the Bachelor of Technology Degree Program Regulations and Curriculum, 2024-2028;*

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

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

hh. *"Registrar" means the Registrar of the University;*

ii. *"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;

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

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

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

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

nn. "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;

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

pp. "UGC" means University Grant Commission;

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

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

5. Program Description

The Bachelor of Technology Degree Program Regulations and Curriculum 2024-2028 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 2024-2028 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. (VLSI)

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

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

6. 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 and 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, 2024-2028, 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 VLSI 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
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	50%
	End Term Examination	50%
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	75%
	End Term Examination	25%
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.	

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) 2024-2028: Summary of Mandatory Courses and Minimum Credit Contribution from various Baskets		
Sl. No.	**Baskets**	**Credit Contribution**
1	Humanities and Social Sciences including Management Courses (HSMC)	9
2	Basic Science Courses (BSC)	17
3	Engineering Science Courses (ESC)	24
4	Professional Core Courses (PCC)	64
5	Professional Elective Courses (PEC)	21
6	Open Elective Courses (OEC)	9
	Project Work (PRW)	16
	Mandatory Courses (MAC)	0
	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 Humanities and Social Sciences including Management Courses (HSMC)

S.No	Course Code	Course Name	L	T	P	C
1	ENG1002	Technical English	1	0	2	2
2	ENG2001	Advanced English	1	0	2	2
3	PPS1001	Introduction to soft skills	0	0	2	1
4	PPS4002	Introduction to Aptitude	0	0	2	1
5	MGTXXXX	Management Course (Select any one course from Management Basket - I)	3	0	0	3
		Total No. of Credits				9

Table 3.2 : List of Basic Science Courses **(BSC)**

S.No	Course Code	Course Name	L	T	P	C
1	MAT1003	Applied Statistics	1	0	2	2
2	MAT1001	Calculus and Linear Algebra	3	0	2	4
3	PHY1002	Optoelectronics & Device Physics	2	0	2	3
4	CHE1017	Applied Chemistry	1	0	2	2
5	MAT2503	Transform Techniques, Partial Differential Equations and Probability	3	0	0	3
6	MAT2504	Numerical Methods, Probability Distributions and Sampling Techniques	3	0	0	3
		Total No. of Credits				17

Table 3.3 : List of Engineering Science Courses **(ESC)**

S.No	Course Code	Course Name	L	T	P	C
1	CIV1008	Basic Engineering Sciences	2	0	0	2
2	CSE1004	Problem Solving Using C	1	0	4	3
3	EEE1007	Basics of Electrical and Electronics Engineering	3	0	2	4
4	CSE1006	Problem Solving using JAVA	1	0	4	3
5	MEC1006	Engineering Graphics	2	0	0	2
6	ECE2010	Innovative Projects using Arduino	-	-	-	1
7	CSExxxx	C Programming and Data Structures	3	0	0	3
8	CSExxxx	C Programming and Data Structures Laboratory	0	0	2	1

9	CSE1700	Essentials of AI	3	0	0	3
10	CSE1701	Essentials of AI Lab	0	0	4	2
		Total No. of Credits				24

Table 3.4 : Professional Core Courses (PCC)

S. No.	Course Code	Course Name	L	T	P	C
1	ECE2015	Circuit Analysis	1	0	2	2
2	ECE2021	Digital Electronics	3	0	0	3
3	ECE2508	Signal Processing	3	1	0	4
4	ECE2012	Solid State Electronics	3	1	0	4
5	ECE2510	Introduction to Fabrication Technology	3	0	0	3
6	ECE2051	Digital Electronics Lab	0	0	2	1
7	ECE2558	Signals Processing Laboratory	0	0	2	1
8	ECE2560	Introduction to Fabrication Technology Lab	0	0	2	1
9	ECE2523	Digital System and VLSI Design using HDL	3	0	0	3
10	ECE2521	Embedded Systems Design using Microcontrollers	4	0	0	4
11	ECE3122	Microelectronics	3	0	0	3
12	ECE2507	Control Systems	3	0	0	3
13	CSEXXXX	Computer Organization and Architecture	3	0	0	3
14	ECE2573	Digital System and VLSI Design using HDL Lab	0	0	2	1
15	ECE2571	Embedded Systems Design using Microcontrollers Lab	0	0	2	1
16	ECE2562	Microelectronics Laboratory	0	0	2	1
17	ECE2513	Introduction to CMOS VLSI Design	3	0	0	3
18	ECE2514	Design for Testability	3	0	0	3

19	ECE2563	Introduction to CMOS VLSI Design Laboratory	0	0	2	1
20	ECE2515	Mixed Signal Circuit Design	3	0	0	3
21	ECE2516	VLSI Design Verification	3	0	0	3
22	ECE2517	Communication Systems	3	1	0	4
23	ECE2566	VLSI Design Verification Laboratory	0	0	2	1
24	ECE2567	Communication Systems Laboratory	0	0	2	1
25	ECE2518	RF Integrated Circuits and systems	3	0	0	3
26	ECE2519	Physical Design and Automation	3	0	0	3
27	ECE2569	Physical Design and Automation Laboratory	0	0	2	1
					Total No. of Credits	64

Table 3.5 : List of course in Project Work basket (PRW)

S.No	Course Code	Course Name	L	T	P	C
1	ECE7000	Internship	-	-	-	2
2	ECE7100	Minor Project	-	-	-	4
3	ECE7300	Capstone Project	-	-	-	10
		Total No. of Credits				16

Table 3.6 : Manadatory Course

S.No	Course Code	Course Name	L	T	P	C
1	CHE1018	Environmental Science	1	0	2	0
2	LAW1008	Indian Constitution and Professional Ethics for Engineers	1	0	0	0
3	PPSXXXX	Industry Preparedness	2	0	0	0
		Total No. of Credits				0

****These are non-credited courses in which the student has to earn a Satisfactory (S) Letter Grade in order to complete their degree.**

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 3.7 : Discipline Elective Courses

S. No.	Course Code	Course Name	L	T	P	C
General Basket						
1	ECE3200	Measuring Instruments and Sensors	3	0	0	3
2	ECE3201	Biomedical Instrumentation	3	0	0	3
3	ECE3202	Data Acquisition Techniques	3	0	0	3
4	ECE3203	Printed Circuit Board Design	3	0	0	3
5	ECE3204	Electronic Controlled Converters	3	0	0	3
6	ECE3205	Industrial Automation and Control	3	0	0	3

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
7	ECE3206	Linear Algebra for Communication Engineering	3	0	0	3
8	ECE3207	Fuzzy Logic and its Engineering Applications	3	0	0	3
Signal Processing Basket						
1	ECE3400	Speech Signal Processing	3	0	0	3
2	ECE3401	Digital Image Processing	3	0	0	3
3	ECE3402	Biomedical Signal Processing	3	0	0	3
4	ECE3403	Adaptive Signal Processing	3	0	0	3
5	ECE3404	Multimedia Signal Processing	3	0	0	3
6	ECE3405	Wavelets and Filter Banks	3	0	0	3
7	ECE3406	Probabilistic Systems analysis	3	0	0	3
8	ECE3407	Video Processing and Computer Vision	3	0	0	3
VLSI Design Basket						
1	ECE3455	VLSI Architecture	3	0	0	3
2	ECE3456	ASIC Design	3	0	0	3
3	ECE3457	Semiconductor Device Modeling	3	0	0	3
4	ECE3458	VLSI DSP Architectures	3	0	0	3
5	ECE3459	Static Timing Analysis	3	0	0	3
6	ECE3460	Mixed Signal Design	3	0	0	3
7	ECE3461	Advanced VLSI and SoC Design	3	0	0	3
8	ECE3462	VLSI Algorithms and Design	3	0	0	3
Embedded Systems Basket						
1	ECE4xxx	Software for Embedded Systems	3	0	0	3
2	ECE3416	Real Time Systems	3	0	0	3
3	ECE3417	DSP Processors	3	0	0	3
4	ECE3418	FPGA Design for Embedded Systems	3	0	0	3
5	ECE3419	Developing Secure Embedded Systems	3	0	0	3
6	ECE3420	Introduction to Embedded Machine Learning	3	0	0	3
7	ECE3421	Deep Learning Using FPGAs	3	0	0	3
8	ECE3422	Fault-Tolerant Embedded Systems	3	0	0	3
Communication Basket						
1	ECE3423	Information Theory and Coding	3	0	0	3
2	ECE3424	Satellite Communication	3	0	0	3
3	ECE3425	Wireless Communication and Networks	3	0	0	3
4	ECE3426	Radar Engineering	3	0	0	3
5	ECE3427	RF Engineering	3	0	0	3
6	ECE3428	Wireless Adhoc Networks	3	0	0	3
7	ECE3429	Optical Communication	3	0	0	3

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
8	ECE3430	Mobile Communication	3	0	0	3
Wearable Technologies Basket						
1	ECE3431	Fundamentals of Wearable Sensing	3	0	0	3
2	ECE3432	Flexible Electronics and Sensors	3	0	0	3
3	ECE3433	Wearable Devices and Its Applications	3	0	0	3
4	ECE3434	Embedded Platforms for Wearables	3	0	0	3
5	ECE3435	Wireless Technologies for Wearables	3	0	0	3
6	ECE3436	Wearable Internet of Things (WIoT)	3	0	0	3
7	ECE3437	Wearable and Ubiquitous Computing	3	0	0	3
8	ECE3438	Wearable Prosthetics and Robots	3	0	0	3
IoT & Sensor Technologies Basket						
1	ECE3439	IoT: Architecture and Protocols	3	0	0	3
2	ECE3440	Hardware and Software Architectures for IoT Systems	3	0	0	3
3	ECE3441	IoT Edge Nodes and its Applications	3	0	0	3
4	ECE3442	IoT and Cloud Computing	3	0	0	3
5	ECE3443	Data Science for IoT	3	0	0	3
6	ECE3444	Industrial Internet of Things (IIoT)	3	0	0	3
7	ECE3445	Internet of Medical Things (IoMT)	3	0	0	3
8	ECE3446	Internet of Agricultural Things (IOAT)	3	0	0	3
Artificial Intelligence Basket						
1	ECE3447	Computational Intelligence and Machine Learning	3	0	0	3
2	ECE3448	Neural Networks and Deep Learning	3	0	0	3
3	ECE3449	Applications of Deep Learning	3	0	0	3
4	ECE3450	Applied Pattern Recognition	3	0	0	3
5	ECE3451	AI & Digital Health	3	0	0	3
6	ECE3452	Natural Language Processing	3	0	0	3
7	ECE3453	Reinforcement Learning	3	0	0	3
8	ECE3454	Explainable AI	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	CHE1006	Introduction to Nano technology	3	0	0	3
4	CHE1011	Chemical and Petrochemical catalysts	3	0	0	3
5	CHE1013	Chemistry for Engineers	3	0	0	3
6	CHE1014	Surface and Coatings technology	3	0	0	3
7	CHE1016	Forensic Science	3	0	0	3
Civil Engineering Basket						
1	CIV1001	Disaster mitigation and management	3	0	0	3
2	CIV1002	Environmental 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	Environmental 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	COM2007	Basics of Accounting	3	0	0	3
Computers Basket						
1	CSEXXXX	Problem Solving Using C	2	0	0	2
2	CSEXXXX	Problem Solving Using C Lab	0	0	2	1
3	CSExxxx	Problem Solving using JAVA	2	0	0	1
4	CSExxxx	Problem Solving using JAVA Lab	0	0	2	2
5	CSE2003	Social Network Analytics	3	0	0	3
6	CSE2005	Web design fundamentals	2	0	2	3
7	CSE3111	Artificial Intelligence : Search Methods For Problem Solving	3	0	0	3
8	CSE3112	Privacy And Security In Online Social Media	3	0	0	3
9	CSE3113	Computational Complexity	3	0	0	3
10	CSE3114	Deep Learning for Computer Vision	3	0	0	3
11	CSE3115	Learning Analytics Tools	3	0	0	3
Design Basket						
1	DES2001	Design Thinking	3	0	0	3
2	DES2080	Art of Design Language	3	0	0	3
3	DES2081	Brand Building in Design	3	0	0	3
4	DES2085	Web Design Techniques	3	0	0	3
5	DES2089	3D Modeling for Professionals	1	0	4	3
6	DES2090	Creative Thinking for Professionals	3	0	0	3
7	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	ECE3800	Fundamentals of Electronics	3	0	0	3
2	ECE3801	Microprocessor based systems	3	0	0	3
3	ECE3802	Artificial Neural Networks	3	0	0	3
4	ECE3803	Smart Electronics in Agriculture	3	0	0	3
5	ECE3804	Environment Monitoring Systems	3	0	0	3
6	ECE3805	Consumer Electronics	3	0	0	3
7	ECE3806	Product Design of Electronic Equipment	3	0	0	3
8	ECE3807	Introduction to Data Analytics	3	0	0	3
9	ECE3808	Machine Vision for Robotics	3	0	0	3
English Basket						
1	ENG1009	Reading Advertisement	3	0	0	3
2	ENG1010	Verbal Aptitude for Placement	2	0	2	3
3	ENG1011	English for Career Development	3	0	0	3
4	ENG1013	Indian English Drama	3	0	0	3
5	ENG1014	Logic and Art of Negotiation	2	0	2	3
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	KAN1003	Kannada Kaipidi	3	0	0	3
2	KAN2005	Anuvadha Kala Sahithya	3	0	0	3
3	KAN2006	Vichara Manthana	3	0	0	3
4	KAN2007	Katha Sahithya Sampada	3	0	0	3
5	KAN2008	Ranga Pradarshana Kala	3	0	0	3
Foreign Language Basket						
1	FRL1009	Mandarin Chinese for Beginners	3	0	0	3
Law Basket						
1	LAW2014	Introduction to Competition Law	3	0	0	3
2	LAW2015	Cyber Law	3	0	0	3
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	PET1011	Energy Industry Dynamics	3	0	0	3
2	PET1012	Energy Sustainability Practices	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	PHY1007	Physics of Nanomaterials	3	0	0	3
5	PHY2004	Laser Physics	3	0	0	3
6	PHY2005	Science and Technology of Energy	3	0	0	3
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	MGT2008	Econometrics for Managers	3	0	0	3
13	MGT2009	Management Consulting	3	0	0	3
14	MGT2010	Managing People and Performance	3	0	0	3
15	MGT2011	Personal Finance	3	0	0	3
16	MGT2012	E Business for Management	3	0	0	3
17	MGT2013	Project Management	3	0	0	3
18	MGT2014	Project Finance	3	0	0	3
19	MGT2015	Engineering Economics	3	0	0	3

20	MGT2016	Business of Entertainment	3	0	0	3
21	MGT2017	Principles of Management	3	0	0	3
22	MGT2018	Professional and Business Ethics	3	0	0	3
23	MGT2019	Sales Techniques	3	0	0	3
24	MGT2020	Marketing for Engineers	3	0	0	3
25	MGT2021	Finance for Engineers	3	0	0	3
26	MGT2022	Customer Relationship Management	3	0	0	3
27	MGT2023	People Management	3	0	0	3
Media Studies Basket						
1	BAJ3051	Digital Photography	2	0	2	3
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. (Electronics and Communication Engineering)

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. (Electronics and Communication Engineering)

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	CIV1008	Basic Engineering Sciences	2	0	0	2	2	ESC	F	
2	CSE1004	Problem Solving Using C	1	0	4	3	5	ESC	F	
3	EEE1007	Basics of Electrical and Electronics Engineering	3	0	2	4	5	ESC	F	
4	MAT1003	Applied Statistics	1	0	2	2	3	BSC	F/S	
5	ENG1002	Technical English	1	0	2	2	3	HSMC	F	
6	PPS1001	Introduction to soft skills	0	0	2	1	2	HSMC	S	HP
7	LAW1008	Indian Constitution and Professional Ethics for Engineers	1	0	0	0	1	MAC	S	
8	CHE1018	Environmental Science	1	0	2	0	3	MAC	F	ES
		TOTAL				14	24			

Semester 2										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			

1	CSE1006	Problem Solving using JAVA	1	0	4	3	5	ESC	F	
2	MAT1001	Calculus and Linear Algebra	3	0	2	4	5	BSC	F	
3	PHY1002	Optoelectronics & Device Physics	2	0	2	3	4	BSC	F	
4	MEC1006	Engineering Graphics	2	0	0	2	2	ESC	S	
5	ECE2015	Circuit Analysis	1	0	2	2	3	PCC	S/EM	
6	ENG2001	Advanced English	1	0	2	2	3	HSMC	S	
7	ECE2010	Innovative Projects using Arduino	-	-	-	1	0	ESC	F	
8	PPS1012	Enhancing Personality through Soft Skill	0	0	2	1	2	HSMC	S	HP
9	CHE1017	Applied Chemistry	1	0	2	2	3	BSC	S	
		TOTAL				20	27	-	-	-

Semester 3										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**						**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**	**BASKET**		
1	MAT2503	Transform Techniques, Partial Differential Equations and Probability	3	0	0	3	3	BSC	F	
2	ECE2021	Digital Electronics	3	0	0	3	3	PCC	F	
3	ECE2508	Signal Processing	3	1	0	4	4	PCC	F	
4	ECE2012	Solid State Electronics	3	1	0	4	4	PCC	F	
5	ECE2510	Introduction to Fabrication Technology	3	0	0	3	3	PCC	C	
6	CSEXXXX	C Programming and Data Structures	3	0	0	3	3	ESC	S/EM	HP/GS
7	XXXXXXX	Open Elective - I	3	0	0	3	3	OEC	S	
8	ECE2051	Digital Electronics Lab	0	0	2	1	2	PCC	S	
9	ECE2558	Signals Processing Laboratory	0	0	2	1	2	PCC	S	
10	ECE2560	Introduction to Fabrication Technology Lab	0	0	2	1	2	PCC	F	
11	CSEXXXX	C Programming and Data Structures Laboratory	0	0	2	1	2	ESC		
12	MAT2503	Transform	3	0	0	3	3	BSC		

		Techniques, Partial Differential Equations and Probability								
		TOTAL				26	29	-	-	-

Semester 4										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	MAT2504	Numerical Methods, Probability Distributions and Sampling Techniques	3	0	0	3	3	BSC	F	
2	ECE2523	Digital System and VLSI Design using HDL	3	0	0	3	3	PCC	F	
3	ECE2521	Embedded Systems Design using Microcontrollers	4	0	0	4	4	PCC	F	
4	ECE3122	Microelectronics	3	0	0	3	3	PCC	F	
5	ECE2507	Control Systems	3	0	0	3	3	PCC	EM	
6	CSEXXXX	Computer Organization and Architecture	3	0	0	3	3	PCC	Em	
7	ECEXXXX	Professional Elective - I	3	0	0	3	3	PEC	S/EM/ EN	
8	ECE2573	Digital System and VLSI Design using HDL Lab	0	0	2	1	2	PCC	S/EM	HP/GS
9	ECE2571	Embedded Systems Design using Microcontrollers Lab	0	0	2	1	2	PCC		
10	ECE2562	Microelectronics Laboratory	0	0	2	1	2	PCC		
		TOTAL				25	24	-	-	-

Semester 5										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	ECE2513	Introduction to CMOS VLSI Design	3	0	0	3	3	PCC	F	F
2	ECE2514	Design for Testability	3	0	0	3	3	PCC	F/EM	F/EM
3	CSE1700	Essentials of AI	3	0	0	3	3	ESC	F	F
4	ECEXXXX	Professional Elective	3	0	0	3	3	PEC	F/EM	F/EM

		- II								
5	ECEXXXX	Professional Elective - III	3	0	0	3	3	PEC	EM	EM
6	MGTxxxx	Management Course (Select any one course from Management Basket - I)	3	0	0	3	3	HSMC	EM	EM
7	ECE2563	Introduction to CMOS VLSI Design Laboratory	0	0	2	1	2	PCC	S/EM/EN	S/EM/EN
8	CSE1701	Essentials of AI Lab	0	0	4	2	4	ESC	F	
9	ECE7100	Minor Project	-	-	-	4	-	PRW	F	
		TOTAL				25	24	-	-	-

Semester 6										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	ECE2515	Mixed Signal Circuit Design	3	0	0	3	3	PCC	F/EM	
2	ECE2516	VLSI Design Verification	3	0	0	3	3	PCC	F/ EM/ EN	
3	ECE2517	Communication Systems	3	1	0	4	4	PCC	F/ EM	
4	ECEXXXX	Professional Elective - IV	3	0	0	3	3	PEC	F/EM	
5	ECEXXXX	Professional Elective - V	3	0	0	3	3	PEC	EM	
6	XXXXXXX	Open Elective - II	3	0	0	3	3	OEC	EM	
7	ECE2566	VLSI Design Verification Laboratory	0	0	2	1	2	PCC	S/EM/EN	
8	ECE2567	Communication Systems Laboratory	0	0	2	1	2	PCC	F/EM	
		TOTAL				23	24	-	-	-

Semester 7						
			CREDIT STRUCTURE			**COURSE**

S. NO.	COURSE CODE	COURSE NAME	L	T	P	C	CONTACT HOURS	BASKET	TYPE OF SKILL	ADDRESSES TO
1	ECE2518	RF Integrated Circuits and systems	3	0	0	3	3	PCC	EM	
2	ECE2519	Physical Design and Automation	3	0	0	3	3	PCC	EM	
3	ECEXXXX	Professional Elective - VI	3	0	0	3	3	PEC	EM	
4	ECEXXXX	Professional Elective - VII	3	0	0	3	3	PEC	EM	
5	XXXXXXX	Open Elective - III	3	0	0	3	3	OEC	EM	
6	ECE2569	Physical Design and Automation Laboratory	0	0	2	1	2	PCC	S/EM/EN	
7	ECE7000	Internship	-	-	-	2	-	PRW	EN	
		TOTAL				14	11	-	-	-

Semester 8										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	ECE7300	Capstone Project	-	-	-	10		PRW	F/EM	
		TOTAL				10	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 Code: EEE1007	**Course Title: Basics of Electrical and Electronics Engineering. Type of Course: Engineering Science - Theory & Integrated Laboratory**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**NIL**					
Course Description	This is a fundamental Course which is designed to know the use of basics of electrical and electronics engineering principles occurs in various fields of Engineering. The course emphasis on the characteristics and applications of electrical and electronic devices, working, analysis and design of electrical circuits using both active & passive components, fundamentals of electrical machines and basics of transistors and its application. The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain **Skill Development** through **Experiential Learning**					

<table>
<tr><td></td><td colspan="4">techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

1. Explain basic laws of Electrical Engineering to compute voltage, currents and other parameters in the circuits.
2. Discuss various fundamental parameters appearing in the characteristics of semiconductor devices and their applications.
3. Summarize the operations of different biasing configurations of BJTs and amplifiers.
4. Summarize the performance characteristics and applications of various electrical Machines.
5. Demonstrate the working of electrical machines to observe performance characteristics
6. Demonstrate the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Electrical Circuits</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td>10 Sessions</td></tr>
<tr><td colspan="5">DC Circuits: Concept of Circuit and Network, Types of elements, Network Reduction Techniques- Series and parallel connections of resistive networks, Star–to-Delta Transformations, Mesh Analysis, Numerical examples.

AC Circuits: Fundamentals of single phase circuits - Series RL, RC and R-L-C Circuits, Concept of active power, reactive power and Power factor, Numerical examples.

Introduction to three phase system and relation between line and phase values in Star & Delta connection, Numerical examples.</td></tr>
<tr><td>Module 2</td><td>Semiconductor and Diode applications</td><td>Assignment/ Quiz</td><td>Memory Recall based Quizzes</td><td>11 Sessions</td></tr>
<tr><td colspan="5">Mass Action Law, Charge densities in a semiconductor, Types of SC, Junction diodes -Ideal and practical behaviour, Modelling the Diode Forward Characteristic, and Diode applications like rectifiers, Clipping and clamping circuits. Zener diode, characteristics and its applications like voltage regulator.</td></tr>
<tr><td>Module 3</td><td>Fundamentals of Electrical Machines</td><td>Assignment/ Quiz</td><td>Memory Recall-based Quizzes</td><td>12 Sessions</td></tr>
<tr><td colspan="5">Electrical Machines: Single phase transformers: principle of operation and EMF equation, Numerical examples. DC Motor: principle of operation, Back EMF, torque equation, Numerical examples. AC Motor: Principle operation of Induction Motors and its Applications.

Special Machines: Introduction to special electrical machines and its applications.</td></tr>
</table>

Module 4	**Transistors and its Applications**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**

Transistor characteristics, Current components, BJT Configurations (CB, CC, CE configurations) and their current gains. Operating point, Biasing & stabilization techniques: Fixed Bias, Voltage divider bias and its stability factor and load line analysis. Single and multistage amplifier, Darlington pair.

JFET (Construction, principal of Operation and Volt –Ampere characteristics). Pinch- off voltage, Comparison of BJT and FET. MOSFET (Construction, principal of Operation and symbol), MOSFET characteristics in Enhancement and Depletion modes.

Text Book(s):

1. Kothari D. P. & Nagrath I. J., "Basic Electrical and Electronics Engineering", Tata McGraw-Hill Education.
2. Theraja B.L. and Theraja A.K., "A Textbook of Electrical Technology: Basic Electrical Engineering" in S.I. System of Units, 23rd ed., New Delhi: S. Chand, 2002.
3. A.P.Malvino, Electronic Principles,7thEdition, Tata McGraw Hill,2007
4. J. Millman, C. C. Halkias and C. D. Parikh, "Millman's Integrated Electronics", McGraw Hill Education, 2nd Edition.
5. Basics of Electrical & Electronics Laboratory Manual.

Reference Book (s):

1. John Hiley, Keith Brown and Ian McKenzie Smith, "HUGHES Electrical and Electronic Technology", 10th Edition (Indian Edition published by Dorling Kindersley), Pearson,2011
2. Samarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, Prentice Hall India, 2007.
3. K Uma Rao, A Jaya Lakshmi, "Basic Electrical engineering" IK International publishing house Pvt. Ltd
4. R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education India 7th Edition.
5. A K. Maini, V. Agrawal, "Electronic Devices & Circuits", Wiley, 2nd Edition
6. A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition

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

1. https://presiuniv.knimbus.com/user#home
2. https://www.digimat.in/nptel/courses/video/108105112/L01 "Fundamentals of Electrical Engineering-Basic Concepts, Examples"
3. Seminar Topic: https://nptel.ac.in/courses/108/105/108105153/ "Electrical Measurements"
4. Video lectures on "Electronic Devices" by Prof. Dr. A. N. Chandorkar, IIT Bombay http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html
5. Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/108/102/108102095/
6. Video lectures on "Diodes", by Prof. Chitralekha Mahanta, IIT Guwahati, https://nptel.ac.in/courses/117/103/117103063/
7. "Introduction to Electrical Machines https://nptel.ac.in/courses/108/102/108102146/"

8. M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET CurrentVoltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243 https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727
9. F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron DeviceLetters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. https://ieeexplore-ieeeorg-presiuniv.knimbus.com/document/9764749
10. M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053
11. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334

Topics relevant to "SKILL DEVELOPMENT": Performing suitable experiments to compute the Electrical and electronics circuit parameters, performance operation of Machines, and semiconductor devices for **Skill Development** through **Experiential Learning techniques.** This is attained through assessment component mentioned in course plan.

Catalogue prepared by	Mr. Sunil Kumar, Dr. Ashutosh Anand, Dr. Dharmesh Srivastav, Dr. Azra Jeelani
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: EEE1xxx	**Course Title: Basics of Electrical and Electronics Engineering. Type of Course: Engineering Science - Laboratory**	**L-T-P-C**	0	0	2	1
Version No.	1.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**NIL**					
Course Description	This is a fundamental Course which is designed to know the use of basics of electrical and electronics engineering principles occurs in various fields of Engineering. The course emphasis on the characteristics and applications of electrical and electronic devices, working, analysis and design of electrical circuits using both active & passive components, fundamentals of electrical machines and basics of transistors and its application. The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Basics of Electrical and Electronics Engineering and attain **Skill Development** through **Experiential Learning** techniques.					
Course Outcomes	**On successful completion of this Lab the students shall be able to:** 7. **Demonstrate** the working of electrical machines to observe performance characteristics. 8. **Demonstrate** the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices.					
Course Content:						

List of Laboratory Tasks:

Experiment No 1: Verification of KVL and KCL for a given DC circuit.
Level 1: Study and Verify KVL and KCL for the given electrical Circuit.
Level 2: For the same circuit considered in level 1, perform the Simulation using NI LabVIEW/Multisim/MATLAB.

Experiment No 2: Analyse AC series circuits – RL, RC and RLC .

Level 1: Conduct an experiment to perform and verify the impedance, current and power of Series RL and RC circuits

Level 2: Conduct an experiment to perform and verify the impedance and current of RLC series circuits.

Experiment No 3: Calculation of power and power factor of the given AC Circuit.

Level 1: Conduct an experiment to measure the power and power factor for given resistive load.

Level 2: Conduct an experiment to measure the power and power factor for given inductive

load.

Experiment No 4: Perform the experiments on given Transformer.

Level 1: Verify the EMF equation of a transformer and compute the voltage transformation ratio.

Level 2: Study the effect of load on the secondary side of the transformer and verify the EMF equation under load conditions.

Experiment 5: Load test on DC shunt motor

Level 1: Conduct load test on DC shunt motor and find its efficiency at different loads

Level 2: Conduct load test on DC shunt motor and plot the performance characteristics.

Experiment 6: Study of PN-Junction Diode Characteristics in Forward and Reverse Bias Conditions.
Level 1: Carry out an experiment to plot VI Characteristics and hence find the cut-in voltage on forward characteristics for the Silicon P-N Junction diode.
Level 2: Carry out an experiment to plot VI Characteristics of Zener diode and hence find the zener voltage on reverse characteristics for the Silicon P-N Junction zener diode.

Experiment 7: 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 8: 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 9: 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 Z_{in} input impedance and Z_{out} output impedance for Emitter Follower.

Experiment 10: 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: **Targeted Applications:** Application Area includes all electrical and electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). The students will be able to join a profession which involves basics to high level of electronic circuit design. Professionally Used Software: Matlab/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..	
Text Book(s): **6.** Basics of Electrical & Electronics Laboratory Manual.	
Topics relevant to "SKILL DEVELOPMENT": Performing suitable experiments to compute the Electrical and electronics circuit parameters, performance operation of Machines, and semiconductor devices for **Skill Development** through **Experiential Learning techniques.** This is attained through assessment component mentioned in course plan.	
Catalogue prepared by	Mr. Sunil Kumar, Dr. Ashutosh Anand, Dr. Dharmesh Srivastav, Dr. Azra Jeelani
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: ECE2001	**Course Title: Analog Electronics** **Type of Course: Program Core Theory only**	**L-T-P-C**	**3**	0	0	3
Version No.	2.0					
Course Pre-requisites	Semiconductor Physics, Diodes Characteristics, Biasing, Bipolar Junction Transistor: Symbol, Working. Zener Diode: Symbol & Characteristics & Breakdown.					
Anti-requisites	**NIL**					
Course Description	**The course provides insights into the fundamentals of electronic devices. The course discusses the characteristics and applications of electronic devices. The course emphasizes on working, analysis and design of electronic circuits using active components. Additionally, this course creates a foundation for future courses such as Linear Integrated Circuits, Analog Communication and Digital Communication etc.** **The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.**					
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 fundamental parameters appearing in the characteristics of semiconductor devices and their applications 2) **Summarize** the operations of different biasing configurations of BJTs and amplifiers. 3) **Explain** various types, characteristics and modes of FETs 4) **Review** the operation of feedback amplifiers the working of various Oscillators 5) **Demonstrate** the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices. 6) **Sketch** the characteristics and waveforms relevant to standard electronic circuits					
Course Content:						
Module 1	**Diode Applications**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**		
Topics: Mass Action Law, Application of diodes - Clipping and clamping circuits. Zener diode, characteristics and its applications. Biasing & stabilization techniques.						
Module 2	**BJT**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**		
Topics: Thermal runaway**.** Hybrid model, h-parameter equivalent circuits. Small signal model. Classification of Amplifiers, Frequency Response, RC coupled amplifiers: analysis and frequency response, mid-band gain Cascading Transistor amplifiers, Darlington pair.						
Module 3	**Field Effect Transistor**	Assignment/ Quiz	Memory Recall based Quizzes	**8 Sessions**		
Topics: JFET (Construction, principal of Operation and Volt – Ampere characteristics). Pinch- off voltage - small signal model of JFET. FET as Voltage variable resistor, Comparison of BJT and FET. MOSFET						

(Construction, principal of Operation and symbol), MOSFET characteristics in Enhancement and Depletion modes. FET Amplifiers: FET Common source Amplifier, Common Drain Amplifier, Generalized FET Amplifier, FET biasing.

Module 4	**Feedback Amplifiers and Oscillators Circuits**	Assignment/ Quiz	Memory Recall based Quizzes	**10 Sessions**

Topics:

Feedback Amplifiers: Classification of Feedback amplifiers and the Feedback concept, Negative Feedback amplifiers, Voltage-Series and Current-Series Feedback, Current-Shunt and Voltage-Shunt Feedback.

Oscillators Circuit: Barkhausen's Criterion, RC Phase-shift oscillator, Colpitts and Hartley Oscillators, Power Amplifiers**.**

Targeted Application & Tools that can be used:

Targeted Applications: Application Area includes all electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). 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. 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. Case Study: - 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

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13. R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education India 7th Edition.
14. A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition

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

1. Video lectures on "Electronic Devices" by Prof. Dr. A. N. Chandorkar, IIT Bombay http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html
2. Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/108/102/108102095/
3. Video lectures on "Diodes", by Prof. Chitralekha Mahanta, IIT Guwahati, https://nptel.ac.in/courses/117/103/117103063/
4. https://presiuniv.knimbus.com/user#home

E-content:

1. M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET Current Voltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243 https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727
2. F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. https://ieeexplore-ieeeorg- presiuniv.knimbus.com/document/9764749
3. M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053
4. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334

Topics related to development of “FOUNDATION”: Semiconductor Physics
Topics related to development of “EMPLOYABILITY”: Amplifiers, Oscillators
Topics related to development of “ENTREPRENEURSHIP”:
Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”:
Topics related to development of “HUMAN VALUES AND PROFESSIONAL ETHICS”:

Catalogue prepared by	Mrs. Kehkeshan Jalall S
Recommended by the Board of Studies on	**BOS Meeting NO: 12th, Dated BOS 10/08/2021**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE2001	**Course Title: Analog Electronics** **Type of Course: Program Core Theory &Integrated Laboratory**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Semiconductor Physics, Diodes Characteristics, Biasing, Bipolar Junction Transistor: Symbol, Working. Zener Diode: Symbol & Characteristics & Breakdown.						
Anti-requisites	**NIL**						
Course Description	**The course provides insights into the fundamentals of electronic devices. The course discusses the characteristics and applications of electronic devices. The course emphasizes on working, analysis and design of electronic circuits using active components. Additionally, this course creates a foundation for future courses such as Linear Integrated Circuits, Analog Communication and Digital Communication etc.** **The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.**						
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 fundamental parameters appearing in the characteristics of semiconductor devices and their applications 2) **Summarize** the operations of different biasing configurations of BJTs and amplifiers. 3) **Explain** various types, characteristics and modes of FETs 4) **Review** the operation of feedback amplifiers the working of various Oscillators 5) **Demonstrate** the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices. 6) **Sketch** the characteristics and waveforms relevant to standard electronic circuits						
Course Content:							
Module 1	**Diode Applications**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**			
Topics: Mass Action Law, Application of diodes - Clipping and clamping circuits. Zener diode, characteristics and its applications. Biasing & stabilization techniques.							
Module 2	**BJT**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**			
Topics: Thermal runaway**.** Hybrid model, h-parameter equivalent circuits. Small signal model. Classification of Amplifiers, Frequency Response, RC coupled amplifiers: analysis and frequency response, mid-band gain Cascading Transistor amplifiers, Darlington pair.							
Module 3	**Field Effect Transistor**	Assignment/ Quiz	Memory Recall based Quizzes	**8 Sessions**			
Topics: JFET (Construction, principal of Operation and Volt – Ampere characteristics). Pinch- off voltage - small							

signal model of JFET. FET as Voltage variable resistor, Comparison of BJT and FET. MOSFET (Construction, principal of Operation and symbol), MOSFET characteristics in Enhancement and Depletion modes. FET Amplifiers: FET Common source Amplifier, Common Drain Amplifier, Generalized FET Amplifier, FET biasing.

Module 4	**Feedback Amplifiers and Oscillators Circuits**	Assignment/ Quiz	Memory Recall based Quizzes	**10 Sessions**

Topics:

Feedback Amplifiers: Classification of Feedback amplifiers and the Feedback concept, Negative Feedback amplifiers, Voltage-Series and Current-Series Feedback, Current-Shunt and Voltage-Shunt Feedback.

Oscillators Circuit: Barkhausen's Criterion, RC Phase-shift oscillator, Colpitts and Hartley Oscillators, Power Amplifiers**.**

Targeted Application & Tools that can be used:

Targeted Applications: Application Area includes all electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). 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:

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Text Book(s):

1. J. Millman, C. C. Halkias and C. D. Parikh, "Millman's Integrated Electronics", McGraw Hill Education, 2nd Edition.
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17. A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition

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

5. Video lectures on "Electronic Devices" by Prof. Dr. A. N. Chandorkar, IIT Bombay http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html
6. Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/108/102/108102095/
7. Video lectures on "Diodes", by Prof. Chitralekha Mahanta, IIT Guwahati, https://nptel.ac.in/courses/117/103/117103063/
8. https://presiuniv.knimbus.com/user#home

E-content:

5. M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET Current Voltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243 https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727
6. F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. https://ieeexplore-ieeeorg- presiuniv.knimbus.com/document/9764749
7. M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053
8. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334

Topics related to development of “FOUNDATION”: Semiconductor Physics
Topics related to development of “EMPLOYABILITY”: Amplifiers, Oscillators
Topics related to development of “ENTREPRENEURSHIP”:
Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”:
Topics related to development of “HUMAN VALUES AND PROFESSIONAL ETHICS”:

Catalogue prepared by	Mrs. Kehkeshan Jalall S
Recommended by the Board of Studies on	**BOS Meeting NO: 12th, Dated BOS 10/08/2021**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: **ECE2001**	**Course Title:** **Analog Electronics Laboratory** **Type of Course:** **Program Core Theory &Integrated Laboratory**	**L-T-P-C**	0	0	2	1
Version No.	2.0					
Course Pre-requisites	Semiconductor Physics, Diodes Characteristics, Biasing, Bipolar Junction Transistor: Symbol, Working. Zener Diode: Symbol & Characteristics & Breakdown.					
Anti-requisites	**NIL**					
Course Description	**The course provides insights into the fundamentals of electronic devices. The course discusses the characteristics and applications of electronic devices. The course emphasizes on working, analysis and design of electronic circuits using active components. Additionally, this course creates a foundation for future courses such as Linear Integrated Circuits, Analog Communication and Digital Communication etc.** **The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.**					
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 fundamental parameters appearing in the characteristics of semiconductor devices and their applications 2) **Summarize** the operations of different biasing configurations of BJTs and amplifiers. 3) **Explain** various types, characteristics and modes of FETs 4) **Review** the operation of feedback amplifiers the working of various Oscillators 5) **Demonstrate** the working of electronic circuits to obtain the V-I Characteristics of various semiconductor devices. 6) **Sketch** the characteristics and waveforms relevant to standard electronic circuits					
Course Content:						

List of Laboratory Tasks:

Experiment No. 1: 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 2: 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 3: 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 Z_{in} input impedance and Z_{out} output impedance for Emitter Follower.

Experiment 4: 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 5: 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.

Experiment 6: To implement oscillator circuit using BJT and observe the output waveforms.
Level 1:
Identify the components required to implement a Hartley Oscillator. Rig up the circuit and sketch the output waveform. Determine the frequency of the oscillations.
Level 2: NA

Experiment 7: Implement a Colpitts Oscillator and determine the frequency of oscillations.
Level 1: Implement a Colpitts Oscillator and determine the frequency of oscillations. Rig up the circuit and sketch the output waveform. Determine the frequency of the oscillations.
Level 2: NA

Experiment 8: To use transistor as a switch to operate a relay to ON/ OFF an LED
Level 1:
Identify the components required to demonstrating switching operation of transistor. Rig up the circuit and observe the LED output turning ON/OFF
Level 2: NA

Targeted Application & Tools that can be used:

Targeted Applications: Application Area includes all electronic circuits (power supply unit, regulator unit, embedded devices, hardware electronics etc.). 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:

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E-content:

9. M. -Y. Kao, H. Kam and C. Hu, "Deep-Learning-Assisted Physics-Driven MOSFET Current Voltage Modeling," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 974-977, June 2022, doi: 10.1109/LED.2022.3168243 https://ieeexplore-ieee-org-resiuniv.knimbus.com/document/9758727
10. F. Bonet, O. Aviñó-Salvadó, M. Vellvehi, X. Jordà, P. Godignon and X. Perpiñà, "Carrier Concentration Analysis in 1.2 kV SiC Schottky Diodes Under Current Crowding," in IEEE Electron Device Letters, vol. 43, no. 6, pp. 938-941, June 2022, doi: 10.1109/LED.2022.3171112. https://ieeexplore-ieeeorg- presiuniv.knimbus.com/document/9764749
11. M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053
12. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in submicron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 0.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334

Topics related to development of “FOUNDATION”: Semiconductor Physics
Topics related to development of “EMPLOYABILITY”: Amplifiers, Oscillators
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Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”:
Topics related to development of “HUMAN VALUES AND PROFESSIONAL ETHICS”:

Catalogue prepared by	Mrs. Kehkeshan Jalall S
Recommended by the Board of Studies on	**BOS Meeting NO: 12th, Dated BOS 10/08/2021**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE2002	**Course Title:** Digital Electronics **Type of Course:** Program Core Theory	**L-T-P- C**	**3**	**0**	**0**	**3**
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 & Data	**15 Classes**		

			Analysis task	

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]**

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	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE2002	**Course Title:** Digital Electronics Laboratory **Type of Course:** Program Core	**L-T-P- C**	**0**	**0**	**2**	**1**
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:** vii. **Discuss** the concepts of number systems, Boolean algebra and logic gates. viii. **Apply** minimization techniques to simplify Boolean expressions. ix. **Demonstrate** the Combinational circuits for a given logic x. **Illustrate** the Sequential and programmable logic circuits xi. **Implement** various combinational logic circuits using gates. xii. **Verify** the performance of various sequential logic circuits using gates.					
Course Content:						

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):

3. Mano, M. Morris and Ciletti Michael D., *"Digital Design"*, Pearson Education, 6th edition
4. 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)

7. **eBook1**: Mano, M. Morris and Ciletti Michael D., *"Digital Design"*, Pearson Education.
8. {[PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download }
9. **eBook2:**Floyd "DIGITAL LOGIC DESIGN" fourth edition- ePub, eBook- [PDF] DIGITAL LOGIC DESIGN FOURTH EDITION FLOYD | abri.engenderhealth.org.
10. NPTEL Course- NPTEL :: Electrical Engineering - NOC:Digital Electronic Circuits

11. Digital Logic Design PPT Slide 1 (iare.ac.in)
12. 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:

5. 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.
6. 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)
7. 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.
8. 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	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE2015	**Course Title:** Circuit Analysis **Type of Course:** Program Core & Theory only	**L-T-P-C**	**2**	**0**	**0**	**2**
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.					
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 Sess**		
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

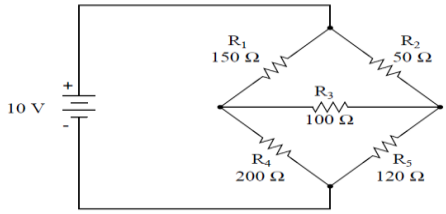
Professionally Used Software: Pspice, Multisim

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.

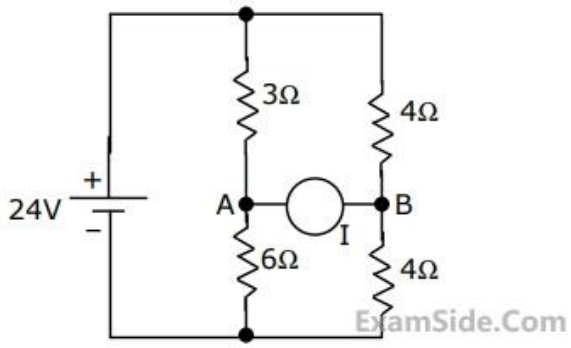
Assignment:
1. Solve network problems by applying Superposition/ Thevenin's/ Norton's/ Maximum Power Transfer Network Theorems and electrical laws to reduce circuit complexities and to arrive at feasible solutions.
2.Calculate current and voltages for the given circuit under transient conditions
3.Apply 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	BOS Meeting NO: 12th, Dated BOS 10/08/2021

Board of Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3001	**Course Title:** **Linear Integrated Circuits** **Type of Course:** **Program Core**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Knowledge of passive and active elements, basics of diode – forward and reverse biasing, diode current equation, Transistors - BJT, Rectifiers. Network theorems- KCL, KVL, Voltage divider rule, super position theorem etc.					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to appreciate the behaviour of operational amplifier based electronic circuits. This course introduces the fundamentals of analog computers. This course emphasizes on the use of operational amplifiers, their characteristics to design various analog circuits. The course also gives a brief idea about operational amplifier based integrated circuits. The associated laboratory provides an opportunity to validate the concepts taught in theory. It also enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools.					
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 the course the students shall be able to: i. Describe the block diagram and characteristics of op-amp. ii. Demonstrate linear applications of op-amp. iii. Employ op-amp for various nonlinear applications. iv. Implement various applications of op-amp using IC 741. v. Illustrate Astable and Monostable Multivibrator using Timer IC 555.					
Course Content:						
Module 1	Introduction to op-amp	Quiz	Memory Recall based Quiz		**10 Sessions**	
Topics: Introduction to op-amp, block diagram, op-amp IC, op-amp symbol, equivalent circuit, transfer characteristics and ideal characteristics of op-amp, op-amp parameters, open loop op-amp configurations - inverting, non-inverting and differential mode, concept of virtual ground.						
Module 2	Linear Applications of op-amp	Assignment	Simulation tasks		**15 Sessions**	
Topics: Non-inverting amplifier, Inverting amplifier, Voltage follower circuit, Summing amplifiers, Average circuit, Difference amplifiers, op-amp as ideal and practical Differentiator circuit, op-amp as ideal and practical Integrator Circuit, V to I Converter, I to V Converter, Instrumentation amplifier Circuit, AC amplifier, Operational transconductance amplifier (OTA), Sample and hold circuit, Multiplier and Divider using op-amp.						
Module 3	Non Linear Applications of op-amp	Quiz & Assignment	Quiz based on Numerical solving. Assignment based on Simulation		**15 Sessions**	
Topics: Comparators, Zero crossing detector, Schmitt trigger circuit. Square and Triangular waveform generators, IC 555 timer - Monostable Multivibrator, Astable Multivibrator. Filters – Low pass filter and high pass filter.						

Voltage regulators- Introduction, Series op-amp regulator, 723 general purpose regulator.

Converters- Introduction to ADC and DAC, Analysis of 3-bit binary weighted DAC, Analysis of 3-bit R-2R DAC, successive approximation ADC.

List of Laboratory Tasks:

Experiment No 1: To setup an Inverting amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of Inverting amplifier for the gain of 10 and input resistance of 1kΩ.
Level 2: Build the circuit of an inverting amplifier for a gain of 5 and input resistance of 1kΩ to avoid op-amp going into saturation.

Experiment No. 2: To setup a Non-Inverting amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of Non-Inverting amplifier for the gain of 10 and input resistance of 1kΩ.
Level 2: Build the circuit of open loop Non-Inverting amplifier, compare with closed loop circuit and comment on the observations.

Experiment No. 3: To setup an Inverting Summing amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of an Inverting Summing amplifier for the gain of 2 with dc voltage of 1.5v.
Level 2: Build the circuit to mix a sinusoidal signal and a dc signal without saturation for an amplification factor of 10.

To setup a zero-crossing detector circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of a zero-crossing detector for the gain of 2 with input voltage of 2Vp-p.
Level 2: NA

Experiment No. 4: To setup a Difference amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of a Difference amplifier for the gain of 2 with the input signal of DC value of 1.5 V and the sinusoidal voltage of 1V p-p.
Level 2: Built the circuit to mix a sinusoidal signal and a dc signal without saturation for an amplification factor of 2.

Experiment No. 5: Build the circuit of Differentiator and Integrator and observe the waveforms.
Level 1: Build an integrator and a differentiator circuit using op-amp for a square wave input. Plot the output you obtained.
Level 2: In continuation with Level 1, determine the relation between the time period of the waveform and RC time constant of the circuit you have used. Plot the output obtained for different input frequencies.

Experiment No. 6: To obtain the frequency response of active low pass and high pass filters and determine 3dB frequencies of both filters.
Level 1: Plot the frequency response for the first order low-pass and high-pass filter with a cut-off frequency of 10kHz with a pass band gain of 1.5.
Level 2: In continuation with Level 1, analyze the circuit to achieve frequency scaling.

Experiment No. 7: Generation of sine, square and triangular waveform using op-amp.
Level 1: Construct a Wien bridge oscillator using op-amp 741 and (i) Plot the output waveform (ii) Measure the frequency of oscillation.
Level 2: Set up the frequency range in order to obtain triangular wave from square wave using Op-Amp 741 and plot the output waveform.

Experiment No. 8: To set up Astable and Monostable Multivibrator using IC 555.
Level 1: Setup Astable and Monostable Multivibrator using IC 555, plot the output waveform.
Level 2: Setup Astable Multivibrator using IC 555 for t1 = 0.7ms.

Targeted Application & Tools that can be used:

Targeted Applications: Automotive technologies, personal electronics, consumer appliances etc. This course is useful for placement in core companies, research & development work.

Professionally Used Software: NI Multisim, LabVIEW, PSpice etc., device setup in laboratory.

Project work/Assignment:

Project Assignment:

1. Build Voltage Regulator (LM 317) to power up various devices
2. How to make an Adjustable Power supply using LM 317 voltage Regulator
3. Operational Amplifier 741 IC Tester
4. Battery Voltage State Indicator using 741
5. Electronic Room Thermometer Using Op-amp 741

Assignment 1:

A circuit consists of an amplifier which does not provide any phase shift. The feedback network used is called a lead-lag network. Identify and explain the working of above circuit with neat diagram and relevant equations. Determine whether the above circuit satisfies Barkhuasen's criteria, if yes determine the frequency of the circuit. Given R=5.1kΩ, C=0.001μF, RF =6kΩ and R1=2kΩ.

Assignment 2:

A simple temperature control circuit can be constructed using a thermistor in the transducer bridge. The circuit produces the output voltage for any change in the temperature. The circuit is also used for such a low-level amplification with high CMRR, high input impedance, high slew rate and low power consumption. Identify the circuit, explain the same with neat circuit diagram, Derive the Equation for output voltage.

Text Books:

1. David A Bell, "Operational Amplifiers and Linear ICs", 3rd edition, Oxford University Press

Reference Books:

1. Gayakwad Ramakant A. "Op-Amps and Linear Integrated Circuits", Pearson , Fourth Edition, Pearson.

2. Maheshwari L. K. and Anand M. M. S., "Analog Electronics", PHI, 2009

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

1. Document on Integrated Circuit. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/integrated-circuit

2. NPTEL Video lectures on Integrated circuits, MOSFETs, OPAMPs and their applications by Prof. Hardik Jeetendra Pandya, IISC Bangalore, https://nptel.ac.in/courses/108/108/108108111/

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

E-content:

1. Q. He and D. Jiao, "Fast Electromagnetics-Based Co-Simulation of Linear Network and Nonlinear Circuits for the Analysis of High-Speed Integrated Circuits," in IEEE Transactions on Microwave Theory and Techniques, vol. 58, no. 12, pp. 3677-3687, Dec. 2010, doi: 10.1109/TMTT.2010.2086590.

2. Chen Tian, Jianyong Lu, Liu Jun, Huaguo Liang, Yingchun Lu, Maoxiang Yi, A reconfigurable test method based on LFSR for 3D stacking integrated circuits, Integration, Volume 87, 2022, Pages 82-89, ISSN 0167-9260, https://doi.org/10.1016/j.vlsi.2022.06.011.

3. Abdelaziz Lberni, Amin Sallem, Malika Alami Marktani, Nouri Masmoudi, Abdelaziz Ahaitouf, Ali Ahaitouf, Influence of the operating regimes of MOS transistors on the sizing and optimization of CMOS analog integrated Circuits, AEU - International Journal of Electronics and Communications, Volume 143, 2022, 154023, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154023.

4. Di Li, Chun Wang, Xinhui Cui, Dongdong Chen, Chunlong Fei, Yintang Yang, Recent progress and development of interface integrated circuits for piezoelectric energy harvesting, Nano Energy, Volume 94, 2022, 106938, ISSN 2211-2855, https://doi.org/10.1016/j.nanoen.2022.106938.

Topics related to development of "FOUNDATION": op-amp characteristics and parameters.

Topics related to development of "EMPLOYABILITY": All linear and non-linear applications of op-amp.

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": NIL					
Catalogue prepared by	Mrs. Samreen Fiza				
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021				
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022				
Course Code: **ECE3002**	**Course Title:** **Digital Signal Processing** **Type of Course: Program Core** **Theory &Integrated Laboratory**	**L-P-C**	**3**	**2**	**4**
Version No.	2.0				
Course Pre-requisites	**Basic concepts of Signals and Systems and their representation and modeling, Concept of Z-Transform and DTFT. Concepts of Matrices.**				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to support the students 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. The associated laboratory provides an opportunity to validate the concepts learnt in theory to visualize the real-world problems in order to provide a solution using various MATLAB simulation tool boxes.**				
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:** i) **Describe** the basic concepts of DSP with Discrete Fourier Transforms and Signal Convolution ii) **Apply** the FFT algorithm for the discrete sequence iii) **Develop and realize** the transfer functions of IIR filters. iv) **Compute** the transfer function of FIR filters and their realization. v) **Execute** the program for computation of DFT. vi) **Demonstrate** the design techniques to implement digital filters.				
Course Content:					
Module 1	**Basics of DSP with DFT Convolution**	Application Assignment	Data Analysis task	**9***Sessions*	
Overview and applications of DSP- Sampling Theorem: Introduction and needs of Transformation (i)DTFT (ii) DFT -Properties of DFT, Problems on DFT and IDFT, Introduction to Circular convolution, Circular convolution-Concentric circle method and Matrix multiplication method.					
Module 2	**FFT Algorithms**	Application Assignment	Data Analysis task	9*Sessions*	
Introduction to FFT, Comparison of FFT with Direct evaluation of the DFT, DIT-algorithm: Radix-2 DIT-FFT algorithm and its problems. Overview of DIF-algorithm					
Module 3	**IIR Filter Design and Realizations**	Application Assignment	Data Analysis task	**11***Sessions*	

Introduction of filters, Types of filters - IIR filters, Butterworth filters and Chebyshev filters. Design of analog low pass Butterworth and conversion to digital low pass using Impulse Invariance method and Bilinear transformation. Overview of Frequency transformation. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

Module 4	**FIR Filter Design and Realizations**	Application Assignment	Data Analysis task	**11***Sessions*

FIR filter design using windows (Rectangular/Hamming/ Hanning window), Frequency sampling method. FIR filter structures - direct form realizations - linear phase structure realizations.

List of Laboratory Tasks:

Experiment N0 1: Write the Matlab code, to find the Circular convolution of two sequences.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete mathematical functional representation.

Experiment N0 2:
Write the Matlab code, to compute of N point DFT of a give sequence and to plot magnitude and phasespectrum.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

Experiment N0 3:
Write the Matlab code, to find Circular convolution of two given sequences using DFT and IDFT.
Level 1: Using FFT function
Level 2: Using direct formula method.

Experiment N0 4:
Write the Matlab code, to Construct theButterworth IIR filter for given specification.
Level 1: Specification given directly
Level 2: Specification given indirectly–Taking the input signal from real-time sources.

Experiment N0 5:
Write the Matlab code, to construct the FIR filterby using different windows to meet given specification.
Level 1: Specification given directly
Level 2: Specification given indirectly-Taking the input signal from real-time sources.

Experiment N0 6:
Write the Matlab code, to Find h[n] of the difference equation and plot impulse response and pole-zero plots.
Level 1: Difference equation is described directly
Level 2: Difference equation described indirectly.

Experiment N0 7:
Study of DSP KIT and Code Composer Studio.
Level 1: NA
Level 2: NA

Experiment N0 8:
Find Circular convolution of two given sequences on DSP Board with CCS.
Level 1: The input data provided as discr Ms. Akshaya M Ganorkarete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

Experiment N0 9:
Computation of N point DFT of a given sequences on DSP Board with CCS.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

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). The students will be able to join a profession which involves basics to a high level of digital signal processing and analysis.
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.Case Studies: At the end of the course students will be given a real-world scenario for any application like face recognition based security systems, speech translation systems etc. Students will be submitting a report which will include Truth table, Design, Circuit Diagrams, implementation and Results.

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: "A system with any arbitrary input signal investigates the response is known as filter/Transfer function. If it satisfy the linear and time-invariant principles is called as LTI system. Most real systems have non-linear input/output characteristics, but many systems, when operated within nominal parameters have behavior close enough to linear that LTI system theory is an acceptable representation of the input/output behavior. The relationships may described by a difference equations. Identify the type of filter which is described by the following difference equation,y(n)=2x(n)+3x(n-1)+x(n-2)+4x(n-3)+x(n-4)+3x(n-5)+2x(n-6)?

5.Assignment 2: DSP can be found in almost all field of engineering applications, it takes the input like audio, video, temperature or pressure, and manipulates them mathematically. It manipulates the input signals with the intention of filtering, measuring, or compressing and producing analog signals. Theoretically following statements are derived,

1) Exact reconstruction of a continuous time signal from its samples is possible if the signal is band limited.
2) The sampling frequency is greater than twice the signal bandwidth.
3) The minimum sampling frequency 2Fmax is needed to avoid aliasing. Statement 1 is True, Remaining false statement 1 & 2 are True statement 3 is True, Remaining false
4) All are true.

Text Book(s):

1. John Proakis, Dimitris G Manolakis, "Digital Signal Processing Principles, Algorithms and Application", PHI, 3rd Edition (2000).
2. A.V.Oppenheim and R.W.Shafer, "Discrete-Time Signal Processing", PHI, 3rd Edition

References:

Reference Book(s):

1. Li Tan & Jean Jiang " Digital Signal Processing- Fundamentals and Applications" 2nd Edition, 2013 Elsevier Digital_Signal_Processing_2nd_Ed_Fundame.pdf
2. Lonnie.C.Ludeman, "Fundamentals of Digital Signal Processing ", John Wiley, 2009 1ST Edition
3. Ganesh Rao "Digital Signal Processing", Pearson Education, 2nd Edition

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

1. Overview Basic SignalRepresentationhttp://users.ece.utexas.edu/~bevans/courses/realtime/lectures/midterm1.html
2. Introduction to FFT Digital Signal Processing Tutorial (tutorialspoint.com)
3. Filter Design and Realizations FOR DSP PRESENTATION (wustl.edu)
4. Introduction to Digital Signal Processing Course | MATLAB Helper ® - YouTube
5. Introduction to Signal Processing - YouTube
6. Digital signal processing (slideshare.net)Dsp ppt (slideshare.net)
7. https://presiuniv.knimbus.com/user#/home

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	Dr. G. Muthupandi Mr. Sunil Kumar Dasari Mrs. Diana Steffi Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE2008	**Course Title: Signals and Systems** **Type of Course: Program Core** **Theory only**		**L-T-P-C**	3	1	0	4
Version No.	1.0					
Course Pre-requisites	An understanding of basic concepts of linear circuits as examples of linear systems and a familiarity with complex numbers and calculus, including power series are desirable.					
Anti-requisites	**NIL**					
Course Description	**This is an undergraduate level course that builds a mathematical foundation for understanding and analyzing any physical system. This course will teach signal/system properties, sampling, frequency transforms and responses, feedback, control applications as well as computer analysis using MATLAB/Python. The course feeds into several applications, including Data Science, Machine Learning, Communications, Networks and Systems.**					
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) **Understand** basic concepts of discrete-time signals and linear time invariant (LTI) systems to provide their time-domain and frequency-domain descriptions. (2) **Employ** Fourier analysis of signals and LTI systems. (3) **Implement** simple discrete-time systems, such as linear filters.					
Course Content:						
Module 1	**Introduction to Signals and Systems**	Assignment / Quiz	Memory Recall based Quizzes/ Programming and Simulation task	**15 session**		
Topics: What are signals, What are systems, Classification of signals, Classification of systems, Transformation of independent variable-time shifting, time scaling and time reversal, Properties of signals, Different types of elementary signals- unit-step, rectangular, triangular, unit-impulse, ramp signal, Continuous time systems, Block diagram representation of systems, Properties of systems- memory, causality, invertibility, time invariance, linearity, stability, Continuous time Linear Time-Invariant (LTI) Systems, Properties of continuous time LTI systems, Discrete time Linear Time-Invariant (LTI) Systems, Continuous time and discrete time convolution.						
Module 2	Fourier Series and Fourier Transform	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**15 session**		
Topics: Continuous time Fourier Series, Fourier series representation of continuous time periodic signals, Convergence and properties of continuous-time Fourier series, Continuous time Fourier series and Frequency spectra, Discrete time Fourier series and its properties, Discrete time Fourier series and Frequency spectra , Continuous time Fourier transform and its properties, Convergence of Continuous time Fourier Transform, Representation of aperiodic signal, Discrete-time Fourier transform and its properties, Convergence of Discrete time Fourier Transform, Sampling, Duality in discrete-time Fourier series.						
Module 3	z-transform and Filter Design	Assignment / Quiz	Programming Assignment	**15 session**		
Topics: Laplace transform, ROC, Inverse Laplace transform, Filter design by placements of poles and zeros of system functions, properties of Laplace transform, analysis and characterization of LTI systems using Laplace transform, unilateral Laplace transform. Z- transform, properties of z- transform, Frequency						

response from pole-zero location, analysis and characterization of LTI systems using z-transform, unilateral z-transform. IIR/ FIR Filters.

List of Laboratory Tasks: Nil

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, Simulink

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 .**

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 Signals and Systems using MATLAB/ SIMULINK

Text Book(s):

1. Alan V Oppenheim, Alan S Willsky and S.Hamid Nawab, “Signals and systems”, Pearson Education,2nd edition,2003

Reference(s):

Reference Book(s):

1. B P Lathi, “Linear Systems and Signals” (The Oxford Series in Electrical and Computer Engineering) 2004
2. Signals and systems, second edition - Simon Haykin, Barry VanVeen, Wiley, Wiley India,2007

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

1. Signals and Systems | MIT OpenCourseWare
2. Signals and Systems | Electrical Engineering and Computer Science | MIT OpenCourseWare
3. Presidency University Library Link https://presiuniv.knimbus.com/user#/home

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”: CTFT, CTFS, DTFT, DTFS, Laplace Transform and Z Transform

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3001	**Course Title:** **Linear Integrated Circuits** **Type of Course:** **Program Core**	**L-T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Knowledge of passive and active elements, basics of diode – forward and reverse biasing, diode current equation, Transistors - BJT, Rectifiers. Network theorems- KCL, KVL, Voltage divider rule, super position theorem etc.					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to enable the students to appreciate the behaviour of operational amplifier based electronic circuits. This course introduces the fundamentals of analog computers. This course emphasizes on the use of operational amplifiers, their characteristics to design various analog circuits. The course also gives a brief idea about operational amplifier based integrated circuits. The associated laboratory provides an opportunity to validate the concepts taught in theory. It also enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools.					
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 the course the students shall be able to: vi. Describe the block diagram and characteristics of op-amp. vii. Demonstrate linear applications of op-amp. viii. Employ op-amp for various nonlinear applications. ix. Implement various applications of op-amp using IC 741. x. Illustrate Astable and Monostable Multivibrator using Timer IC 555.					
Course Content:						
Module 1	Introduction to op-amp	Quiz	Memory Recall based Quiz			**10 Sessions**
Topics: Introduction to op-amp, block diagram, op-amp IC, op-amp symbol, equivalent circuit, transfer characteristics and ideal characteristics of op-amp, op-amp parameters, open loop op-amp configurations - inverting, non-inverting and differential mode, concept of virtual ground.						
Module 2	Linear Applications of op-amp	Assignment	Simulation tasks			**15 Sessions**
Topics: Non-inverting amplifier, Inverting amplifier, Voltage follower circuit, Summing amplifiers, Average circuit, Difference amplifiers, op-amp as ideal and practical Differentiator circuit, op-amp as ideal and practical Integrator Circuit, V to I Converter, I to V Converter, Instrumentation amplifier Circuit, AC amplifier, Operational transconductance amplifier (OTA), Sample and hold circuit, Multiplier and Divider using op-amp.						
Module 3	Non Linear Applications of op-amp	Quiz & Assignment	Quiz based on Numerical solving. Assignment based on Simulation			**15 Sessions**
Topics: Comparators, Zero crossing detector, Schmitt trigger circuit. Square and Triangular waveform generators, IC 555 timer - Monostable Multivibrator, Astable Multivibrator. Filters – Low pass filter and high pass filter. Voltage regulators- Introduction, Series op-amp regulator, 723 general purpose regulator. Converters- Introduction to ADC and DAC, Analysis of 3-bit binary weighted DAC, Analysis of 3-bit R-2R						

DAC, successive approximation ADC.

List of Laboratory Tasks:

Experiment No 1: To setup an Inverting amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of Inverting amplifier for the gain of 10 and input resistance of 1kΩ.
Level 2: Build the circuit of an inverting amplifier for a gain of 5 and input resistance of 1kΩ to avoid op-amp going into saturation.

Experiment No. 2: To setup a Non-Inverting amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of Non-Inverting amplifier for the gain of 10 and input resistance of 1kΩ.
Level 2: Build the circuit of open loop Non-Inverting amplifier, compare with closed loop circuit and comment on the observations.

Experiment No. 3: To setup an Inverting Summing amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of an Inverting Summing amplifier for the gain of 2 with dc voltage of 1.5v.
Level 2: Build the circuit to mix a sinusoidal signal and a dc signal without saturation for an amplification factor of 10.

To setup a zero-crossing detector circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of a zero-crossing detector for the gain of 2 with input voltage of 2Vp-p.
Level 2: NA

Experiment No. 4: To setup a Difference amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of a Difference amplifier for the gain of 2 with the input signal of DC value of 1.5 V and the sinusoidal voltage of 1V p-p.
Level 2: Built the circuit to mix a sinusoidal signal and a dc signal without saturation for an amplification factor of 2.

Experiment No. 5: Build the circuit of Differentiator and Integrator and observe the waveforms.
Level 1: Build an integrator and a differentiator circuit using op-amp for a square wave input. Plot the output you obtained.
Level 2: In continuation with Level 1, determine the relation between the time period of the waveform and RC time constant of the circuit you have used. Plot the output obtained for different input frequencies.

Experiment No. 6: To obtain the frequency response of active low pass and high pass filters and determine 3dB frequencies of both filters.
Level 1: Plot the frequency response for the first order low-pass and high-pass filter with a cut-off frequency of 10kHz with a pass band gain of 1.5.
Level 2: In continuation with Level 1, analyze the circuit to achieve frequency scaling.

Experiment No. 7: Generation of sine, square and triangular waveform using op-amp.
Level 1: Construct a Wien bridge oscillator using op-amp 741 and (i) Plot the output waveform (ii) Measure the frequency of oscillation.
Level 2: Set up the frequency range in order to obtain triangular wave from square wave using Op-Amp 741 and plot the output waveform.

Experiment No. 8: To set up Astable and Monostable Multivibrator using IC 555.
Level 1: Setup Astable and Monostable Multivibrator using IC 555, plot the output waveform.
Level 2: Setup Astable Multivibrator using IC 555 for t1 = 0.7ms.

Targeted Application & Tools that can be used:
Targeted Applications: Automotive technologies, personal electronics, consumer appliances etc. This course is useful for placement in core companies, research & development work.

Professionally Used Software: NI Multisim, LabVIEW, PSpice etc., device setup in laboratory.

Project work/Assignment:

Project Assignment:

1. Build Voltage Regulator (LM 317) to power up various devices
2. How to make an Adjustable Power supply using LM 317 voltage Regulator
3. Operational Amplifier 741 IC Tester
4. Battery Voltage State Indicator using 741
5. Electronic Room Thermometer Using Op-amp 741

Assignment 1:
A circuit consists of an amplifier which does not provide any phase shift. The feedback network used is called a lead-lag network. Identify and explain the working of above circuit with neat diagram and relevant equations. Determine whether the above circuit satisfies Barkhuasen's criteria, if yes determine the frequency of the circuit. Given R=5.1kΩ, C=0.001μF, RF =6kΩ and R1=2kΩ.

Assignment 2:
A simple temperature control circuit can be constructed using a thermistor in the transducer bridge. The circuit produces the output voltage for any change in the temperature. The circuit is also used for such a low-level amplification with high CMRR, high input impedance, high slew rate and low power consumption. Identify the circuit, explain the same with neat circuit diagram, Derive the Equation for output voltage.

Text Books:

1. David A Bell, "Operational Amplifiers and Linear ICs", 3rd edition, Oxford University Press

Reference Books:

1. Gayakwad Ramakant A. "Op-Amps and Linear Integrated Circuits", Pearson , Fourth Edition, Pearson.

2. Maheshwari L. K. and Anand M. M. S., "Analog Electronics", PHI, 2009

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

1. Document on Integrated Circuit. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/integrated-circuit

2. NPTEL Video lectures on Integrated circuits, MOSFETs, OPAMPs and their applications by Prof. Hardik Jeetendra Pandya, IISC Bangalore, https://nptel.ac.in/courses/108/108/108108111/

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

E-content:

1. Q. He and D. Jiao, "Fast Electromagnetics-Based Co-Simulation of Linear Network and Nonlinear Circuits for the Analysis of High-Speed Integrated Circuits," in IEEE Transactions on Microwave Theory and Techniques, vol. 58, no. 12, pp. 3677-3687, Dec. 2010, doi: 10.1109/TMTT.2010.2086590.

2. Chen Tian, Jianyong Lu, Liu Jun, Huaguo Liang, Yingchun Lu, Maoxiang Yi, A reconfigurable test method based on LFSR for 3D stacking integrated circuits, Integration, Volume 87, 2022, Pages 82-89, ISSN 0167-9260, https://doi.org/10.1016/j.vlsi.2022.06.011.

3. Abdelaziz Lberni, Amin Sallem, Malika Alami Marktani, Nouri Masmoudi, Abdelaziz Ahaitouf, Ali Ahaitouf, Influence of the operating regimes of MOS transistors on the sizing and optimization of CMOS analog integrated Circuits, AEU - International Journal of Electronics and Communications, Volume 143, 2022, 154023, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154023.

4. Di Li, Chun Wang, Xinhui Cui, Dongdong Chen, Chunlong Fei, Yintang Yang, Recent progress and development of interface integrated circuits for piezoelectric energy harvesting, Nano Energy, Volume 94, 2022, 106938, ISSN 2211-2855, https://doi.org/10.1016/j.nanoen.2022.106938.

Topics related to development of "FOUNDATION": op-amp characteristics and parameters.
Topics related to development of "EMPLOYABILITY": All linear and non-linear applications of op-amp.
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": NIL

Catalogue prepared by	Mrs. Samreen Fiza

Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021				
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022				
Course Code: **ECE3002**	**Course Title:** **Digital Signal Processing** **Type of Course: Program Core Theory &Integrated Laboratory**	**L-P-C**	**3**	**2**	**4**
Version No.	2.0				
Course Pre-requisites	**Basic concepts of Signals and Systems and their representation and modeling, Concept of Z-Transform and DTFT. Concepts of Matrices.**				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to support the students 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. The associated laboratory provides an opportunity to validate the concepts learnt in theory to visualize the real-world problems in order to provide a solution using various MATLAB simulation tool boxes.**				
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:** vii) **Describe** the basic concepts of DSP with Discrete Fourier Transforms and Signal Convolution viii) **Apply** the FFT algorithm for the discrete sequence ix) **Develop and realize** the transfer functions of IIR filters. x) **Compute** the transfer function of FIR filters and their realization. xi) **Execute** the program for computation of DFT. xii) **Demonstrate** the design techniques to implement digital filters.				
Course Content:					
Module 1	**Basics of DSP with DFT Convolution**	Application Assignment	Data Analysis task	**9***Sessions*	
Overview and applications of DSP- Sampling Theorem: Introduction and needs of Transformation (i)DTFT (ii) DFT -Properties of DFT, Problems on DFT and IDFT, Introduction to Circular convolution, Circular convolution-Concentric circle method and Matrix multiplication method.					
Module 2	**FFT Algorithms**	Application Assignment	Data Analysis task	9*Sessions*	
Introduction to FFT, Comparison of FFT with Direct evaluation of the DFT, DIT-algorithm: Radix-2 DIT-FFT algorithm and its problems. Overview of DIF-algorithm					
Module 3	**IIR Filter Design and Realizations**	Application Assignment	Data Analysis task	**11***Sessions*	
Introduction of filters, Types of filters - IIR filters, Butterworth filters and Chebyshev filters. Design of analog low pass Butterworth and conversion to digital low pass using Impulse Invariance method and Bilinear transformation. Overview of Frequency transformation. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.					
Module 4	**FIR Filter Design and Realizations**	Application Assignment	Data Analysis task	**11***Sessions*	

FIR filter design using windows (Rectangular/Hamming/ Hanning window), Frequency sampling method. FIR filter structures - direct form realizations - linear phase structure realizations.

List of Laboratory Tasks:

Experiment N0 1: Write the Matlab code, to find the Circular convolution of two sequences.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete mathematical functional representation.

Experiment N0 2:
Write the Matlab code, to compute of N point DFT of a give sequence and to plot magnitude and phasespectrum.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

Experiment N0 3:
Write the Matlab code, to find Circular convolution of two given sequences using DFT and IDFT.
Level 1: Using FFT function
Level 2: Using direct formula method.

Experiment N0 4:
Write the Matlab code, to Construct theButterworth IIR filter for given specification.
Level 1: Specification given directly
Level 2: Specification given indirectly–Taking the input signal from real-time sources.

Experiment N0 5:
Write the Matlab code, to construct the FIR filterby using different windows to meet given specification.
Level 1: Specification given directly
Level 2: Specification given indirectly-Taking the input signal from real-time sources.

Experiment N0 6:
Write the Matlab code, to Find h[n] of the difference equation and plot impulse response and pole-zero plots.
Level 1: Difference equation is described directly
Level 2: Difference equation described indirectly.

Experiment N0 7:
Study of DSP KIT and Code Composer Studio.
Level 1: NA
Level 2: NA

Experiment N0 8:
Find Circular convolution of two given sequences on DSP Board with CCS.
Level 1: The input data provided as discr Ms. Akshaya M Ganorkarete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

Experiment N0 9:
Computation of N point DFT of a given sequences on DSP Board with CCS.
Level 1: The input data provided as discrete sequence representation with specific length.
Level 2: Data provided as discrete Mathematical functional representation.

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). The students will be able to join a profession which involves basics to a high level of digital signal processing and analysis.
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.Case Studies: At the end of the course students will be given a real-world scenario for any application like face recognition based security systems, speech translation systems etc. Students will be submitting a report which will include Truth table, Design, Circuit Diagrams, implementation and Results.

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: "A system with any arbitrary input signal investigates the response is known as filter/Transfer function. If it satisfy the linear and time-invariant principles is called as LTI system. Most real systems have non-linear input/output characteristics, but many systems, when operated within nominal parameters have behavior close enough to linear that LTI system theory is an acceptable representation of the input/output behavior. The relationships may described by a difference equations. Identify the type of filter which is described by the following difference equation,y(n)=2x(n)+3x(n-1)+x(n-2)+4x(n-3)+x(n-4)+3x(n-5)+2x(n-6)?

5.Assignment 2: DSP can be found in almost all field of engineering applications, it takes the input like audio, video, temperature or pressure, and manipulates them mathematically. It manipulates the input signals with the intention of filtering, measuring, or compressing and producing analog signals. Theoretically following statements are derived,

1) Exact reconstruction of a continuous time signal from its samples is possible if the signal is band limited.
2) The sampling frequency is greater than twice the signal bandwidth.
3) The minimum sampling frequency 2Fmax is needed to avoid aliasing. Statement 1 is True, Remaining false statement 1 & 2 are True statement 3 is True, Remaining false
4) All are true.

Text Book(s):

3. John Proakis, Dimitris G Manolakis, "Digital Signal Processing Principles, Algorithms and Application", PHI, 3rd Edition (2000).
4. A.V.Oppenheim and R.W.Shafer, "Discrete-Time Signal Processing", PHI, 3rd Edition

References:

Reference Book(s):

4. Li Tan & Jean Jiang " Digital Signal Processing- Fundamentals and Applications" 2nd Edition, 2013 Elsevier Digital_Signal_Processing_2nd_Ed_Fundame.pdf
5. Lonnie.C.Ludeman, "Fundamentals of Digital Signal Processing ", John Wiley, 2009 1ST Edition
6. Ganesh Rao "Digital Signal Processing", Pearson Education, 2nd Edition

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

8. Overview Basic SignalRepresentationhttp://users.ece.utexas.edu/~bevans/courses/realtime/lectures/midterm1.html
9. Introduction to FFT Digital Signal Processing Tutorial (tutorialspoint.com)
10. Filter Design and Realizations FOR DSP PRESENTATION (wustl.edu)
11. Introduction to Digital Signal Processing Course | MATLAB Helper ® - YouTube
12. Introduction to Signal Processing - YouTube
13. Digital signal processing (slideshare.net)Dsp ppt (slideshare.net)
14. https://presiuniv.knimbus.com/user#/home

E-content:

4. 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.
5. *Saeed, Ahmed, et al. "Efficient fpga implementation of fft/ifft processor." International Journal of circuits, systems and signal processing 3.3 (2009): 103-110.*
6. 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	Dr. G. Muthupandi Mr. Sunil Kumar Dasari Mrs. Diana Steffi Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	15th BOS held on 28/07/2021
Date of	

Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3003	**Course Title:** Microprocessor Programming and Interfacing **Type of Course:** Program Core Theory &Integrated Laboratory	**L- P- C**	3	2	4
Version No.	1.0				
Course Pre-requisites	**Basic concepts of simple circuit design involving switches and LEDs, their interconnections and current and voltage levels. Basics of logic gates and implementation of digital logic circuits using gates, flip-flops, registers, multiplexers, decoders etc.**				
Anti-requisites	Microprocessor based Systems (ECE1004)				
Course Description	**The purpose of this course is to enable the students to appreciate the fundamentals of microprocessor based systems. The course is both conceptual and analytical which imparts knowledge of both hardware and software leading to a system design used in real-world applications. The course develops critical thinking skills by augmenting the student's quest to develop assembly language programs as well hardware interconnections for commonly used applications. The comprehensive nature of the course covers a number of quizzes, assembly language programming using simulation tools and various interfacing assignments, which enhances students' abilities to become an independent system designer.** The associated laboratory provides an opportunity to validate the concepts taught as well as enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools and hardware interfacing techniques.				
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 this course the students shall be able to:** **(1) Discuss the architecture and working principles of 8085 / 8086 microprocessor.** **(2) Solve assembly language programming problems using coding and debugging skills.** **(3) Demonstrate methods to interface memories, input/output devices and programmable peripheral devices to the microprocessor.** **(4) Illustrate various important features and associated terminologies of advanced microprocessors like 80286-80486 and Pentium.** **(5) Execute assembly language programs for various categories of operations.** **(6) Interface various input / output devices using assembly language programming of programmable peripheral devices.**				
Course Content:					
Module 1	Fundamentals of Microprocessors	Quiz	Memory Recall based Quizzes	**09 Sessions**	

Topics:
Overview of 8086 Microprocessor Architecture, 8086 – 80486 Programming Model, Pin Diagram, Signals, Min/Max Mode, Timing Diagram, Instruction cycle, Machine Cycle and T-states.

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, Memory Classifications, Memory Interfacing: Memory Structure & it's requirement, basic concepts in Memory Interfacing, Input and Output Devices: I/O with 8-bit addresses, I/O with 16-bit addresses.

Module 2	8086 Instruction Sets and Assembly Language Programming	Assignment / Quiz	Programming and Simulation task	**12 Sessions**

Topics:
Instruction Sets: Data movement instructions, Program control instructions, Arithmetic and Logical Instructions, Stack Instructions, String Instructions, Looping, Counting and Indexing Counter and Timing delays, Stack and Subroutines Code conversion, BCD Arithmetic operations, 16-bit data operations, Assembly Language Programs.

Module 3	Interfacing Techniques and Peripheral Interfacing Devices	Assignment	Memory Interfacing Task and Analysis	**12 Sessions**

Topics:
I/O Interfacing: Basic interfacing concept, interfacing output displays, interfacing input devices, memory mapped I/O, comparison of memory mapped I/O and peripheral I/O, Interrupts, Peripheral Devices, Programmable Peripheral Interface (Intel 8255A), Programmable Interval timer (Intel 8253), Other support chips like Interrupt Controller (8259), Direct Memory Access (8237) Controller.

Module 4	Bus Interfaces and Advanced Processors	Assignment	System Design Task and Analysis	**09 Sessions**

Topics:

Buses: 8-bit, 16-bit ISA, USB, COM, LPT

PCI 80186 – 80386 & Pentium: Features, OS & Task Management, Bus Pipelining, Memory Management for 80286 & 80386, Memory Protection, 80486 Features, Cache Organization.

List of Laboratory Tasks:

Experiment No.1: Arithmetic operations using microprocessors
Level 1:
To implement an assembly language program to perform 8-bit/16bit arithmetic operations such as addition, subtraction, multiplication and division.

Level 2:
There are **10 students** in a batch for whom the MPI EXAM is conducted and the marks scored by each students is stored in an array called **"MARKS"** given as **5,5,6,7,8,8,9,9,2,1.** Implement an assembly language program to find the average of the marks scored by these students and store the final result in memory location **"EXAM".** (HINT: Use arithmetic instructions)

Experiment No. 2: Logical operations using microprocessors
Level 1:
To implement an assembly language program to find (bit location / count) logical 1's and 0's in a given input data in memory.

Level 2:

In continuation with the above problem statement, find whether the numerical value given above is even or odd number, if it is an even number store **11h** in memory location **"EVEN"** else store **22h** in memory location **"ODD".** (HINT: Use logical instructions)

Experiment No. 3: Array Operations using microprocessors

Level 1:

To implement an assembly language program to find the largest and smallest numbers in an array.

Level 2:

Implement the following equation using assembly language program given **n x (n-1) x (n-2) x (n-3) x (n-4) x (n-5) x (n-6)** where **"n"** is the hexadecimal number stored in memory location **"INPUT"** and the final answer of the equation should be stored in the memory location **"OUTPUT".** The implementation of the given equation should be written inside the subroutine (HINT: Use program control instructions)

Experiment No. 4: String Operations using microprocessors

Level 1:

Given a string of character **"PRESIDENCY UNIVERSITY",** implement an assembly language program to transfer this string in forward direction from **"MEMORY1"** to **"MEMORY2",** assuming (a) overlapping and (b) non-overlapping memory blocks. (HINT: Use string instructions)

Level 2:

In continuation with the above problem statement, implement an assembly language program to find number of times the character **"E"** appears in the above string mentioned.

Experiment No. 5: DOS Interrupts

Level 1:

To implement an assembly language program using DOS INTERRUPT (INT 21H) in order to perform the following function:

(i) To read string of characters (first 8 natural numbers) from keyboard and also store the ASCII equivalents in data segment memory.

(ii) To display string of character "ECE DEPARTMENT" on the command prompt and also store the ASCII equivalents in data segment memory.

Level 2: NA

Experiment No. 6: Interfacing of stepper motor using programmable peripheral interface.

Level 1:

Implement an assembly language program to interface programmable peripheral device (PPI) to rotate the stepper motor in clockwise direction.

Level 2:

A toy robot has a stepper motor because its movement comprises of discrete steps. In continuation with the above problem statement, implement an assembly language program to interface programmable peripheral device (PPI) to rotate the stepper motor in anti-clockwise direction.

Experiment No.7: Generation of waveforms using DAC.

Level 1:

Implement an assembly language program to interface programmable peripheral device (PPI) to generate square wave on the CRO

Level 2:

Square waves are used as timing references or "clock signals", because their fast transitions are suitable for triggering synchronous logic circuits at precisely determined intervals.

In continuation with the above problem statement, implement an assembly language program to interface programmable peripheral device (PPI) to generate triangle wave on the CRO.

Experiment No.8: Elevator Interfacing

Level 1:

An Elevator, also called lift moves in a vertical shaft to carry passengers between the levels of a multistory building. Say a building has only 4 floors, implement an assembly language program to interface programmable peripheral device (PPI) to control an elevator using the interfacing card available in

laboratory and control its direction between the floors.

Level 2: NA

Targeted Application & Tools that can be used:

Application Area:
Microprocessor-based systems are found everywhere today and not just in computers and smartphones. They are used also in automatic testing of products, speed control of motors, traffic light control, communication equipment, television, satellite communication, home appliances, such as microwave oven, washing machine etc. This course will enable students to become a Firmware Engineer, Computer Hardware Engineer etc.

Professionally Used Software: MASM / emu8086 emulator / 8086 development kits for programming and interfacing experiments.

Project work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based circuits like a Traffic Light System, A Chocolate Vending Machine, 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 Assignment: Carry out a system design on a chart paper for an application using the 8086 microprocessor and various devices including ROMs / RAMs, LEDs / Switches / Actuators and Peripheral Devices like 8255 / 8254 etc.

Assignment: 1] Interface 8086/ 8088 microprocessor with various types of memories and I/O devices.

Assignment 2: Identify the components of an automatic vending machine (chocolate / chips / soft-drinks) and list out various device connections. Indicate the working mechanisms by drawing a flow-chart.

Text Book(s):

1. Brey B. B., "The Intel Microprocessors", Pearson

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. K. R Venugopal & Rajkumar, Microprocessor x86 programming, BPB Publication, 2007.

4. A. K Ray & K. M Bhurchandani, Advance Microprocessor and Periferals, 2nd Edition, Tata McGraw Hill, 2006.

5. 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:

13. 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
14. Brooks, David M., Pradip Bose, Stanley E. Schuster, Hans Jacobson, Prabhakar N. Kudva, Alper Buyuktosunoglu, 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
15. Sima, Dezsö. "Decisive aspects in the evolution of microprocessors." Proceedings of the IEEE, vol. 92, no. 12 (2004), pp. 1896-1926. https://ieeexplore.ieee.org/document/1360164
16. 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
17. Radhakrishnan, Kaladhar, Madhavan Swaminathan, and Bidyut K. Bhattacharyya. "Power delivery for high-performance microprocessors—challenges, solutions, and future trends." IEEE Transactions on Components, Packaging and Manufacturing Technology, vol. 11, no. 4 (2021), pp. 655-671. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9377004

Topics relevant to development of "SKILL": Assembly Language Programming concepts, Memory & I/O Interfacing, Interrupts and Programmable Peripheral ICs.

Catalogue prepared by	Mrs. Priyanka Ray
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3004</td><td colspan="3">Course Title: Electromagnetic Theory
Type of Course: Program Core & Theory only</td><td>L- P- C</td><td>3</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">Basic concepts of Engineering Mathematics, Basic concepts of Engineering Physics</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">This course introduces the basic concepts of electromagnetic theory which is essential for understanding circuit/network theory. This course imparts knowledge to explore numerous technological and scientific applications such as electric generators, electric motors, electrical appliances, electric bells and MRI scanning. This course gives a comprehensive coverage of a wide variety of real life applications related to numerous communication systems. This course also provides an opportunity to validate the concepts of mathematical modeling in the design of almost every electronic device.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of the course the students shall be able to:
1. Discuss the operating principles of electromagnetic field
2. Demonstrate the behavior of light and its nature.
3. Apply the concept of Maxwell Equations which is the heart of Electromagnetics.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Coordinate systems and Vector Analysis</td><td colspan="2">Assignment</td><td colspan="2">Memory Recall based Quizzes</td><td>13 Session</td></tr>
<tr><td colspan="8">Topics:
Introduction, Concepts of fields, Cartesian coordinate, circular cylindrical coordinate, spherical coordinates, Scalar and vectors, vector addition and subtraction, vector multiplication, Differential length, area and volume, line surface and volume integral, Concept of Del operator, Gradient of a scalar, Divergence of a vector field, Curl of a vector field, Laplacian of a scalar field, Divergence and Stokes theorem, Numerical on vector calculus</td></tr>
<tr><td>Module 2</td><td>Electrostatics and Magnetostatics</td><td colspan="2">Assignment / Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>13 Session</td></tr>
<tr><td colspan="8">Topics:
Coulombs law and electric field intensity, Electric field density, Gauss Law and application, Concept of scalar electric potential, Electric field in material space, Electric boundary conditions, Biot-savart law, Ampere circuital law, Application of ampere circuital law, Magnetic flux density, Concept of vector magnetic potential, Magnetic field in material space, Magnetic boundary conditions, Forces due to electric and magnetic field</td></tr>
<tr><td>Module 3</td><td>Maxwell’s Equations</td><td colspan="2">Assignment</td><td colspan="2">Memory Recall based Quizzes</td><td>14 Session</td></tr>
<tr><td colspan="8">Topics:
Introduction, Faradays Law of electromagnetic induction, Transformer and motional EMF, Failure of Amperes law, Concept of displacement current, Maxwell equations in final form, Application of Maxwell Equations, Time harmonic fields, Derivation of wave equation, Wave propagation in Unbound medium</td></tr>
<tr><td colspan="8">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="8">Targeted Application & Tools that can be used:
Student will be able to find the career opportunities in the domains such as Research & Development,</td></tr>
</table>

Communication and Networking, Mobile, RADAR, Space communications.
Professionally Used Software: Ansys HFSS/CST Microwave Studio/MATLAB.

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: Visualization of uniform plane waves in lossless and lossy media in MATLAB, Make a report on Practical applications of Maxwell's four equations in day to day life

Text Books:

1. Matthew N. O. Sadiku, "Elements of Electromagnetics" Oxford University Press, 5th edition

Reference(s):
Reference Book(s):

1. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 2000.

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

1. Video Lecture on Electomagnetic Theory https://youtube.com/playlist?list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT
2. Topics on Radio wave Engineering https://www.sciencedirect.com/topics/engineering/radio-wave
3. Topics on Wave propagation https://www.sciencedirect.com/topics/physics-and-astronomy/wave-propagation
4. Lecture notes on Electomagnetic Theory https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring-2004/pages/lecture-notes/
5. Lecture notes on Electomagnetic Theory https://www.slideshare.net/kumar_vic/electromagnetic-theory
6. Topics on Electomagnetic Theory https://www.sciencedirect.com/topics/computer-science/electromagnetic-theory#:~:text=Electromagnetic%20theory%20based%20on%20Maxwell's,law%20of%20reflection%20in%20optics7. https://presiuniv.knimbus.com/user#/home

E-Content:

[1] C. A Balanis, "Antenna Theory: analysis and Design", Hoboken, NJ: *John Wiley & Sons*, 2005.

[2] W. L. Stutzman, "Polarization in Electromagnetic Systems", *Artech House*, Norwood, 1992.

[3] E. Brookner, W. M. Hall, R. H. Westlake, "Faraday Loss for L-band Radar and Communications Systems", *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-21, no. 4, pp. 459–469, 1985.

[4] J. D. Kraus, "Antennas", McGraw-Hill, New York, 1988.

Topics related to development of "FOUNDATION": Fundamentals of electromagnetics
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": High frequency waves
Topics relevant to development of "SKILL": Maxwell Equations, Motional and Transformer EMF, Amperes Law, Faradays Law.

Catalogue prepared by	Dr. Rakesh Chowdhury
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. 18th , Dated 03/08/2022

Course Code: ECE3005	**Course Title:** Analog Communication **Type of Course:** Program Core Theory &Integrated Laboratory	**L- P-C**	3	2	4
Version No.	2.0				
Course Pre-requisites	Basic concepts of Linear Time- Invariant Systems, Fourier series, Fourier Transforms, representation of signals in time and frequency domain, sampling theorem, diode and transistor characteristics, diode switching times, PLL, VCO and AGC etc.,				
Anti-requisites	**NIL**				
Course Description	This course will introduce the basic concepts and techniques for analog communications. Applications of analog communication systems will be emphasized. It will help the students to form a strong foundation for the specialization in communication engineering. The course will discuss the requirements for modulation before feeding the message signal to the communication channel from the transmitter. Similarly, the role of demodulation techniques at the receiver side will be discussed. The associated laboratory provides an opportunity to validate the concepts taught in theory as well as enhances the ability to visualize communication scenarios in order to provide a solution using various simulation tools and hardware tools.				
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 the course the students shall be able to: i. Discuss the working principles of various amplitude modulation methods. ii. Apply the techniques of frequency modulation to generate and detect FM waves. iii. Summarize various Pulse Modulation techniques. iv. Estimate the spectrum efficiency. v. Analyze the concepts of multiplexing				
Course Content:					
Module 1	Amplitude Modulation & Demodulation:	Assignment	Memory Recall based Quizzes	**10 Sessions**	
Topics: Introduction: Elements of communication systems, Modulation, Modulation Methods and its Need, Frequency mixer, EM Spectrum and its Applications. 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, Features of Vestigial sideband (VSB) modulation, Comparison of various amplitude modulation techniques, Illustrative Problems.					
Module 2	Angle Modulation & Demodulation:	Assignment / Quiz	Design and analysis of parameters (simulation)	**9 Sessions**	
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), Phase modulation, Generation of FM waves – Indirect method, Direct method. Demodulation of FM, Pre-emphasis & De-emphasis filters, Non-linear effects in FM systems, FM Transmitter and Receiver,					

Illustrative Problems.

Module 3	Analog pulse modulation	Assignment	Memory Recall based Quizzes	**8 Sessions**

Topics:
Pulse amplitude modulation (PAM) & demodulation, synchronization in PAM modulation Pulse-Time Modulation – Pulse Duration and Pulse Position modulations, and demodulation schemes, Multiplexing techniques

Module	Noise	Assignment	Memory Recall based Quizzes	**8 Sessions**

Topics:

Introduction to noise in communication, External Noise- Atmospheric noise, Extra-terrestrial noise, Industrial noise; internal noise- Thermal agitation noise, Shot noise, Miscellaneous noise, noise calculation, noise figure, noise temperature.

List of Laboratory Tasks:

Experiment N0 1: Study of Amplitude Modulation And Demodulation

Level 1: A message signal (baseband signal) will be generated by using function generator and high frequency carrier (Pass band Signal) will be used for Modulation. This can be done by either using MatLab Simulink or by using Experimental setup in laboratory.
Level 2: A message signal (baseband signal) will be generated by own circuit and perform the modulation.

Experiment No. 2: Study of AM-DSB-SC modulation and demodulation

Level 1: Similar to previous experiment and how one of the side band will be suppressed. Analysis should be done on power calculations.
Level 2: A message signal (baseband signal) will be generated by own circuit and perform the modulation

Experiment No. 3: Study of AM-SSB-SC modulation and demodulation
Level 1: Pass band signal and Base band signal both will be generate using Function generator.
Level 2: NA
Experiment No. 4: Study of Frequency Division Multiplexing with DSB-SC
Level 1: Two message signals and two carrier signals will be using for FDM
Level 2: analyze the spectrum efficiency of FDM

Experiment No. 5: Study of Frequency modulation and demodulation
Level 1: A message signal (baseband signal) will be generated by using function generator and high frequency carrier (Pass band Signal) will be used for Modulation. This can be done by either using MatLab Simulink or by using Experimental setup in laboratory.
Level 2: A voice signal will be converted to baseband signal.

Experiment No. 6: Study of Pulse Amplitude Modulation and Demodulation
Level 1: Similar to amplitude modulation, here carrier will a periodic pulse train
Level 2: Analyze how PAM will be used in Photo-biology and Ethernet network etc.,

Experiment No. 7: Study of Pulse Position Modulation and Demodulation
Level 1: Both message and carrier signals will be generate from function generator.
Level 2: Analyze how PPM will be used in Non-coherent detection, RF communications and etc.

Experiment No. 8: Study of Pulse Width Modulation and their Demodulation
Level 1: Both message and carrier signals will be generate from function generator.
Level 2: Analyze how PWM will used in contactless smart card, high frequency, RFID (radio frequency ID) tags and etc.

Targeted Application & Tools that can be used:

Targeted Applications: This course is contributed for placement in core companies, research & development work and also useful to know the existing & developing communications.
Professionally Used Software: MatLab, device setup in laboratory.

Project work/Assignment:

Assignment: 1] Calculate AM Modulator and Receiver parameters, for a maximum modulating frequency of 4KHz with Band width of 20KHz.

Assignment 2]: Calculate FM Modulator parameters for a Carrier frequency of 5KHz Deviation sensitivity of 5KHz/V message of 4V and Modulation Index will be 20.

Text Books:

1. Communication Systems, Simon Haykin, Michael Moher, Fifth Edition John Wiley & Sons 2009,
2. Modern Digital and Analog Communication Systems, B.P. Lathi, Zhi Ding, Fourth edition Oxford University Press 2011.

Reference Books:

1. Electronic Communications, Dennis Roddy and John Coolean, Pearson 4th Edition, 2008

2. Communication Systems (Analog and Digital), Dr. Sanjay Sharma, S.K. Kataria & Sons, 2013

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

1. https://youtu.be/iZM2zgxnEOc
2. https://www.sciencedirect.com/topics/engineering/analog-communication
3. https://nptel.ac.in/courses/117105143
4. https://www.slideshare.net/prestonking948/analog-communication

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

E-content:

1. R. Boddeda, S. Almonacil, D. R. Arrieta and S. Bigo, "Analog/Digital Converter Requirements for Coherent Optical Satellite Communications," 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC), 2022, pp. 1-3, doi: 10.23919/OECC/PSC53152.2022.9850076.
https://ieeexplore.ieee.org/document/9850076

2. A. Mezerins and V. Bespal'ko, "Estimation of analog-to-time and time-to-digital conversion efficiency in analog optical communication system testbed," 2015 Advances in Wireless and Optical Communications (RTUWO), 2015, pp. 211-214, doi: 10.1109/RTUWO.2015.7365754.
https://ieeexplore.ieee.org/document/7365754

3. Y. Feng et al., "A 20.8-Gbps dual-carrier wireless communication link in 220-GHz band," in China Communications, vol. 18, no. 5, pp. 210-220, May 2021, doi: 10.23919/JCC.2021.05.013.
https://ieeexplore.ieee.org/document/9444247

4. K. Onohara, J. Nishioka, T. Yoshida and N. Suzuki, "A Study of Multi-Channel Analog-to-Digital Conversion for Beyond-5G Mobile Fronthaul," 2020 Opto-Electronics and Communications Conference (OECC), 2020, pp. 1-3, doi: 10.1109/OECC48412.2020.9273574.
https://ieeexplore.ieee.org/document/9273574

Topics related to development of “FOUNDATION”: Amplitude and angle modulation techniques.
Topics related to development of “EMPLOYABILITY”: All modulation techniques.
Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: FM Spectrum and its Applications

Catalogue prepared by	Mr. G Tirumala Vasu Mr. Ramzan Bhasheer
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021

Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3006	**Course Title:** Digital Control System **Type of Course:** Program Core & Theory only	**L- P- C**	3	0	3
Version No.	1.0				
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, Robotics and so on. 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 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 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		**12 Sessions**
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**

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based topics like tuning of PID controller, calculation of gain and phase margins 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. **Assignment:**

Assignment 1: Modelling the given system in MATLAB/ Octave
Assignment 2: Block diagram reduction in MATLAB/ Octave
Project 1: Model the given translational system. Find the step and impulse response. Verify your result using MATLAB/Octave
Assignment 3: Determine the stability by finding the Gain and Phase Margin using Bode plot in MATLAB/ Octave
Assignment 4: Determining the range of system gain for stability, overdamped response, underdamped response, critically damped response, undamped response using root locus in MATLAB/ Octave
Assignment 5: Model the given system in state space. Check the system for controllability and observability. Find the response of the system in MATLAB/Octave
Project 2: Model an non interacting or interacting liquid level system using transfer function as well as state space and design a certain controller to meet the specifications using MATLAB/Octave

Text Book(s):

1. GF Franklin, JD Powell and ML Workman, 'Digital Control of Dynamic Systems', 3rd Edition, 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, 3rd Edition

2. Constatine H. Houpis and 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/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-10-feedback-and-control/

E-content:

1. 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
2. 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
3. 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
4. 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

Topics relevant to development of “FOUNDATION SKILLS”: Modelling of physical systems using Laplace transform and state space. Reduction of a complex system represented using block diagram
Topics relevant to development of “ENVIRONMENT AND SUSTAINABILITY”: Proportional, Derivative and Integral (PI, PD, PID) Controllers

Catalogue prepared by	Mrs. Priyanka Ray
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3008	**Course Title: VLSI Design** **Type of Course: Program Core Theory &Integrated Laboratory**	**L-P-C**	3	2	4
Version No.	1.0				
Course Pre-requisites	Basic concepts of simple circuit design involving diode and **Transistor**, their interconnections and current and voltage levels. Basics of logic gates and implementation of Digital Logic Circuits using gates, flip-flops, registers, multiplexers, decoders etc.				
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 and digital VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of Hardware Description Language (HDL) to develop designs for high level synthesis and simulation. The embedded lab provides validation of concepts by using various simulation tools and hardware synthesis techniques.**				
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. Discuss the basic concepts of VLSI design. 2. Interpret the MOS transistor theory. 3. Evaluate the working of various CMOS combinational and sequential circuits. 4. Develop combinational and sequential circuits using Hardware Description Language. 5. Compute various design parameters of digital circuits using cadence tool.				
Course Content:					
Module 1	**Verilog HDL and Design Flow**	Quiz	Memory Recall based Quizzes	**11session**	
Topics: Data types, Verilog operators, Verilog Modeling styles. Structural design, Dataflow, Behavioral Design, example programs,Introduction to VLSI: VLSI Design Methodology, VLSI Design Flow(Y Chart), VLSI Design Flow, VLSI Design styles, FPGA, Gate Array Design, Standard Cell design.					
Module 2	**MOS Transistor Parameters**	Assignment / Quiz	Programming and Simulation task	**12 session**	

Topics:
Introduction to fabrication steps: Basic Fabrication steps, NMOS fabrication process, CMOS fabrication process, Twin Tub Process, Introduction to MOS Transistor: Structure and operation of MOS Transistor, MOS Current and Voltage Relationship, Channel Length Modulation, Threshold Voltage Derivation, Substrate Bias Effect/Body Effect, Latch Up, MOS Scaling.

Module 3	**Digital Circuit Design**	Assignment	Analysis and Verification	**17 session**

Topics:
MOS Inverter: Introduction to MOS Inverter and Noise Margin, VTC of CMOS Inverter, Calculation of V_{IH} V_{OH},V_{IL},V_{OL} and V_{TH}, Stick Diagram: Design Rules, Stick Diagram of Inverter, Combinational Logic Gates, Stick Diagram of Combinational Logic Gates, Digital MOS Logic Circuits: Pass Transistor Logic, Transmission Gates Logic, Pseudo NMOS Logic, Dynamic CMOS Logic, Domino CMOS Logic, Timing Issue and Clock Distribution Technique,

Power dissipation in Digital Integrated circuits.

List of Laboratory Tasks:
Experiment No. 1: To Verify Basic Logic Gates using Verilog

Level 1: For the connections of two bulbs there are various ways available, represent two input logic gates using these two bulbs A and B in such a way that they represent gates operation [Represent connections as open and closed switches]
Level 2: Implement Binary to Gray code converter using Basic gates

Experiment No. 2: Write a Verilog code forHalf Adder, Half Subtractor, Full Adder and Full Subtractor. Verify its truth table

Level 1: Construct a circuit to compute addition and subtraction of single bit binary numbers, with Consideration of carry(Borrow) and without considering carry(Borrow).
Level 2: Construct a circuit to implement 4-bit ripple carry adder using 1-bit full adder as sub-block.

Experiment No. 3: Write a Verilog code forMultiplexer, De-multiplexer and Decoder using Verilog. Verify its truth table

Level 1: Implement 3-to-8 decoder circuit using Verilog.
Level 2:Decoder is one of the main combinational components in digital circuits. Decoders are mainly used in memory address decoding and data demultiplexing. Write a Verilog code that outputs 32-bit signal to select the address being written in the memory.

Experiment No. 4: Write a Verilog code forSR, JK, D & T Flip Flops and Counter using Verilog. Verify its truth table

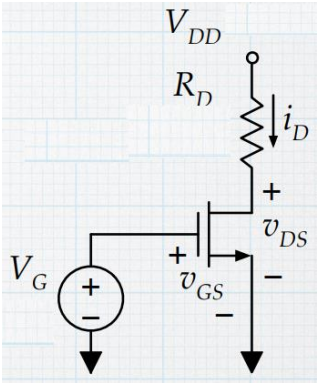
Level 1: Construct SR flip-flop,D Flip-flop and JK Flip-flopincluding a chip select/enable signal with Verilog using case statement and consider falling edge of clock.
Level 2: a) Considering the huge Traffic problems in a metro city, It was decided to build a flexible system where a signal A will be given to start and stop the conventional traffic lights system. For example, if A is 1 then conventional system if ON will become off and If already off then the conventional system will be ON. Implement a system for the above scenario using Flip-flops.
b) Design a circuit for stopwatch which automatically resets after 15 seconds.

Experiment No. 5: Construct a NMOS transistor using the cadence tool andobtain its Static Characteristics.

Level 1: Findthe relationship between Current I_D(Drain current) and Voltage V_{DS} (Drain to Source

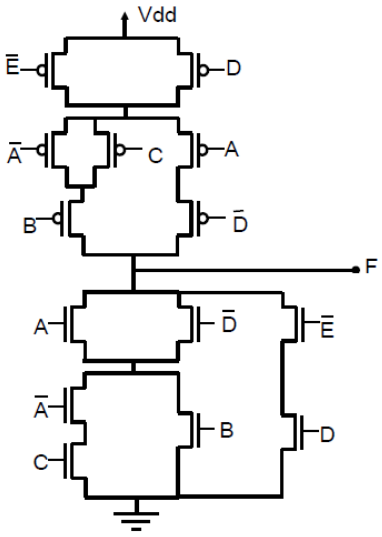
voltage) for different values of Vgs(Gate to Source voltages).

Level 2:For the below circuit find I_D, Vgs and V_{DS}? In which region the transistor is operating? Given V_t=1.5v, $\beta = 1$, V_g=4v, V_{dd}=5v, R_D=1 K ohm, K=0.5mA/V^2



Experiment No. 6: Create a symbol of an inverter using Cadence tool, perform DC analysis and find out delay, rise time, fall time and power dissipation of an inverter.

Level 1:CMOS logic design is commonly used logic style for designing digital circuits. Here, the circuit consists of both pull up network and pull down network consisting of PMOS & NMOS transistors respectively. For the CMOS circuit shown in figure, Obtain the correct Boolean function (F)



Level 2: NA

Experiment No. 7: Construct 2-Input CMOS NAND and NOR Gate using Cadence tool

Level 1:Draw the minimum CMOS transistor network that implements the functionality of Boolean Equation F= (A +(B' + CD)')'. You can assume both the original and complemented versions of each literal are available as gate inputs.
Level 2: Brief the steps involved in Euler rule to draw the stick diagram for CMOS network that implements the functionality of Boolean Equation F= (A +(B' + CD)')'.

Experiment No. 8: Implementation of Common Source (CS) with and without resistive load using Cadence tool.

Level 1: Obtain input and output characteristics of a transistor. **Carry out dc operating point analysis, ac analysis and transient analysis for the same.**

Level 2: Using this amplifier generate a frequency of #value hertz.

Targeted Application & Tools that can be used:

Application:VLSI Technology is one of the most widely used technologies for microchip processors, integrated circuits (IC) and component designing. The students will be able to find career opportunities in various domains such as:

AMS (Analog Mixed Signal) designer.
AMS verification engineer.
Layout design engineer.
ASIC front-end designer.
ASIC verification engineer.
Physical design engineer.
DFT engineer.
Application engineer technical support.
Professionally Used Software: Xilinx and Cadence

Project Work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like traffic light controller, LCD display, DC motor 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 Assignment: Design a cyclic redundancy Checker using Verilog. Compare the power and area consumption for the code using two different approaches. Design and implement in Xilinx-VIVADO. Also perform debugging using the available tools.

Assignment 1: Implement various digital circuits using different descriptions

Assignment 2: There are several logic styles such as static CMOS, pass transistor, pseudo NMOS, dynamic CMOS, domino CMOS, etc., for implementing digital circuits. If it is needed to implement the sum of a half adder circuit using a particular logic style using the minimum number of transistors, then identify the technology used.

Text Book(s):

2. N. Weste and D. Harris, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Addison-Wesley.Fourth Edition
3. Douglas A Pucknell Kamran Eshraghain" Basic VLSI Design", Prentice Hall India Learning Private Limited;Third Edition.Third Edition

Reference(s):
Reference Book(s):

3. Mano, M. Morris and Ciletti Michael D., "*Digital Design*", Pearson Education Sixth Edition
4. N. Weste and K. Eshraghian, "*Principles of CMOS VLSI Design*", Addison-Wesley Second Edition

5. Sung Mo Kang, Yusuf Leblebici"CMOS Digital Integrated Circuits "Mc Gram Hill Education 4th Edition.
6. Debaprasad Das "VLSI Design" Oxford University Press; Second Edition.

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

13. 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 Roorkeehttps://onlinecourses.nptel.ac.in/noc21_ee09/preview

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

E-content:

18. Khailany, B., Krimer, E., Venkatesan, R., Clemons, J., Emer, J. S., Fojtik, M., ... & Zimmer, B. (2018, June). A modular digital VLSI flow for high-productivity SoC design. In *2018 55th ACM/ESDA/IEEE Design Automation Conference (DAC)* (pp. 1-6). IEEE. https://ieeexplore.ieee.org/abstract/document/8465897
19. Sung-Young Lee et al., "A novel multibridge-channel MOSFET (MBCFET): fabrication technologies and characteristics," in IEEE Transactions on Nanotechnology, vol. 2, no. 4, pp. 253-257, Dec. 2003, doi: 10.1109/TNANO.2003.820777. https://ieeexplore.ieee.org/abstract/document/1264877
20. P. Girard, "Survey of low-power testing of VLSI circuits," in IEEE Design & Test of Computers, vol. 19, no. 3, pp. 82-92, May-June 2002, doi: 10.1109/MDT.2002.1003802. https://ieeexplore.ieee.org/abstract/document/1003802
21. Chuang, W., Sapatnekar, S. S., & Hajj, I. N. (1995). Timing and area optimization for standard-cell VLSI circuit design. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, *14*(3), 308-320. https://ieeexplore.ieee.org/abstract/document/365122

Topics related to development of "FOUNDATION": VLSI Design Methodology, Power dissipation in Digital Integrated circuits.
Topics related to development of "EMPLOYABILITY": VLSI Design Flow, Gate Array Design, and Standard Cell Design.
Topics related to development of "ENTREPRENEURSHIP":VLSI Design Flow, Gate Array Design and Standard Cell Design.
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Scaling and Design Rules.
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Application of VLSI design.

Catalogue prepared by	Dr. K BhanuRekha
Recommended by the Board of Studies on	10th BOS held on 17/01/2020
Date of Approval by the Academic Council	Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3009	**Course Title:** Transmission Lines and Waveguides **Type of Course:** Program Core & Theory only	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**The knowledge of vector algebra, basics of electrical engineering, network theory and MATLAB-SIMULINK software tool**				
Anti-requisites	**NIL**				
Course Description	**The course focuses on various types of transmission lines used in daily life. The course includes stub impedance matching, transmission and reception of high frequency waves through co-axial cable and waveguide. This course lays a foundation for many communication related courses like satellite communication, mobile communication, analog and digital communication 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:** 1. Discuss the working of transmission lines such as co-axial cable and associated parameters 2. Compute the calculations pertaining to stub impedance and its parameters 3. Describe the working of waveguide such as rectangular waveguide and associated parameters				
Course Content:					
Module 1	**Transmission Lines and its parameters**	Assignment	Simulation task (transmission lines and its parameters)	**13 Session**	
Topics: Introduction to Transmission lines, transmission line parameters calculation for co-axial cable, Transmission line equations, Concept and numerical on input impedance, Reflection coefficient, VSWR, characteristic impedance, open and short circuited lines.					
Module 2	**Stub impedance matching**	Assignment	Simulation task (stub impedance matching parameters)	**13 Session**	
Topics: Introduction to stub impedance matching, single stub impedance matching and numerical, double stub impedance matching and numerical, Smith chart fundamentals , construction of Smith chart, use of Smith chart to solve stub impedance matching problems, Some applications of transmission lines					
Module 3	**Waveguide**	Assignment	Simulation task (parameters calculation in waveguide)	**13 Session**	
Topics: Introduction, properties and characteristics of waveguides, Applications of Waveguides, General approach to solve field inside waveguide, TM wave in rectangular waveguide, various TM modes, waveguide as a high pass filter, Power transmission and attenuation, TE wave in rectangular waveguide, various TE modes, excitation of waveguides, waveguide terminations, introduction to waveguide resonators					
List of Laboratory Tasks: Nil					
Targeted Application & Tools that can be used: **Application Area:** Telecommunication, Satellite communication, low and high frequency magnetic field transmission, Wireless technology, Optical communication**.** **Professionally Used Hardware/Software:** Arduino/Raspberry Pi , MATLAB/SIMULINK/Arduino/Python					
Project work/Assignment:					
1. Case Studies: At the end of the course students will be given a 'real-world' application based topics like calculations of coaxial cable parameters, reflection coefficient, voltage standing wave ratio 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.
Project Assignment: Software/Hardware implementation of few important concepts studied in this course
Assignment-1: Transmission line parameters measurement for 100m Flexible RG174 Coax Extension Cable Single Shielded with PVC Jacket
Assignment-2: Determination of characteristic impedance of the given transmission line
Assignment-3: Construction of Smith chart using Matlab/Simulink

Text Book(s)

1. K. Giridhar, “Transmission Lines and Wave Guides”, Pooja Publications, India, Fourth Edition.

Reference Book(s):

1. Pramanik, Ashutosh, “Electromagnetism – Theory and Applications”, Prentice-Hall of India Private Limited, Second Edition.

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

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-fall-2005/lecture-notes/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-776-high-speed-communication-circuits-spring-2005/lecture-notes/
3. https://presiuniv.knimbus.com/user#/home

E-content:

5. H. He, B. Li and Y. Sun, "The study of different transmission lines in high speed optical module," 2014 15th International Conference on Electronic Packaging Technology, 2014, pp. 1052-1055, doi: 10.1109/ICEPT.2014.6922826. https://ieeexplore.ieee.org/document/6922826
6. F. Olyslager, "Properties of and generalized full-wave transmission line models for hybrid (Bi)(an)isotropic waveguides," in IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 11, pp. 2064-2075, Nov. 1996, doi: 10.1109/22.543964. https://ieeexplore.ieee.org/document/543964
7. W. J. Getsinger, "An introduction to microwave transmission lines," [1992] Proceedings of the 35th Midwest Symposium on Circuits and Systems, 1992, pp. 1016-1019 vol.2, doi: 10.1109/MWSCAS.1992.271122. https://ieeexplore.ieee.org/document/271122
8. F. Distler, J. Schür and M. Vossiek, "In-depth characterization of a dielectric waveguide for mmW transmission line applications," 2018 IEEE 22nd Workshop on Signal and Power Integrity (SPI), 2018, pp. 1-4, doi: 10.1109/SaPIW.2018.8401671. https://ieeexplore.ieee.org/document/8401671

Topics related to development of “FOUNDATION SKILLS”: Fundamentals of various transmission lines and associated parameters
Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: High frequency waves

Catalogue prepared by	Dr. Rakesh Chowdhury
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. 18th , Dated 03/08/2022

Course Code: ECE3011	**Course Title:** Digital Communication **Type of Course:** Program Core Theory & Integrated Laboratory		**L- P- C**	3	2	4
Version No.	2.0					
Course Pre-requisites	**Basics of analog circuit design, Binary operations in digital electronics, Knowledge of analog communication to highlight its demerits, signals and systems to perform operations on signals and digital signal processing for processing digital signals and for the implementation of digital filters.**					
Anti-requisites	**NIL**					
Course Description	**The course deals with the importance and applications of digital communication for data, video, audio, image transmission and reception. The course is conceptual and application oriented. This course acts as a foundation for the future courses in communication domain like mobile communication, antenna and microwave engineering, satellite communication and data communication and networks etc.** 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 <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 the subsystem components needed to build both wired and wireless digital communication systems. 2] Describe various processes involved in the pulse code modulation and demodulation in wired communication. 3] Demonstrate various processes involved in digital modulation and demodulation in wireless communications. 4] Apply the concepts in power amplifier applications and to choose suitable antenna in digital communication. 5] Implement pulse code modulation technique to convert analog signal into binary data. 6] Carry out pulse code demodulation technique to convert binary data into analog signal.					
Course Content:						
Module 1	Introduction to Digital Communication	Assignment	Simulation task (Conversion of analog signal into samples using Simulink)	**12 classes**		
Topics: **Block diagram of digital communication, Sampling Principles: Sampling Theorem, Quadrature sampling of Band pass signal, Practical aspects of sampling and signal recovery, Hilbert Transform, Pre-envelopes,Comple envelopes**						
Module 2	Waveform coding	Case Study	Simulation task (time division multiplexing modulation and	**12 classes**		

	techniques and Inter Symbol Interference		demodulation)	
Topics: **TDM, PCM, DPCM and DM, Numerical. ISI, Nyquist's criterion for distortion less base-band binary transmission, correlative coding, eye pattern**				
Module 3	Digital Modulation Techniques	Assignment	Simulation task (digital modulation and demodulation techniques using Simulink)	**12 classes**
Topics: **Digital modulation formats, coherent binary modulation techniques, coherent quadrature modulation techniques. Non-coherent binary modulation techniques**				
Module 4	Spread Spectrum Modulation and Detection and Estimation	Assignment	Simulation task (PN sequence generation using Matlab/Simulink)	**12 classes**
Topics: **Pseudo noise sequences, notion of spread spectrum, direct sequence spread spectrum, frequency hop spread spectrum, applications, Numerical. Gram-Schmidt orthogonalization procedure, geometric representation of signals, Probability of error (statement only), Some applications of DS Spread Spectrum Signals, Generation of PN Sequences**				
List of Laboratory Tasks: **Experiment N0 1**: **Level1:** Implementation of sampling circuit to convert given analog signal into its samples with sampling frequency fs≥2fmax 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 2**: **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 3**: **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 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 No. 5:** **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. 6:

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. 7:

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. 8:

Level1:
Integration of all the experiments from 1 to 7, for the demonstration of pulse code modulation and demodulation using LT spice/MATLAB simulation tool.

Level2:
Integration of all the experiments from 1 to 7, 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 data, voice, image, video, text, scanned documents etc. between the two places through wired or wireless communication using digital communication components or systems.

Professionally Used Hardware/Software: DSP processor/Arduino/Raspberry Pi LTSpice /MATLAB/ SIMULINK

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' application based topics like pulse code modulation, delta modulation, binary phase shift keying 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. Assignments: Based on the experiments carried out in this course a assignment project work may be done for the transmission and reception of data, image, video, scanned documents etc.

Assignment 1: The Implementation of Pulse Code Modulation and demodulation for text data transmission and reception in digital format through wired communication (co-axial cable or telephone cable) for short distance (1meter to 10meter). Comment on the speed and clarity of the transmitted and received data.

Assignment 2: Carry out the Binary Phase Shift Keying modulation and demodulation for wireless data transmission and reception of text data in digital format with the suitable carrier wave and appropriate antenna for long distance (greater than 50meter). Comment on the speed and clarity of the transmitted and received data.

Assignment 3: The Implementation of Pulse Code Modulation and demodulation for image transmission and reception in digital format through wired communication (co-axial cable or

telephone cable) for short distance (1meter to 10meter). Comment on the speed and clarity of the transmitted and received data.

Assignment 4: Carry out the Binary Phase Shift Keying modulation and demodulation for wireless data transmission and reception of image in digital format with the suitable carrier wave and appropriate antenna for long distance (greater than 50meter). Comment on the speed and clarity of the transmitted and received data.

Assignment 5: The Implementation of Pulse Code Modulation and demodulation for video transmission and reception in digital format through wired communication (co-axial cable or telephone cable) for short distance (1meter to 10meter). Comment on the speed and clarity of the transmitted and received data.

Assignment 6: Carry out the Binary Phase Shift Keying modulation and demodulation for wireless data transmission and reception of video in digital format with the suitable carrier wave and appropriate antenna for long distance (greater than 50meter). Comment on the speed and clarity of the transmitted and received data.

Text Book(s):

1. **Simon Haykin, "Digital Communication", John Wiley Publication, 2003, 2nd Edition.**
2. **John G. Proakis, "Digital Communication",TMH Publication, 3rd 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 digital communication 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:

9. 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
10. 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
11. W. Litchman, "The Future of Digital Communications," in IEEE Transactions on Communications Systems, vol. 11, no. 2, pp. 149-158, June 1963, doi: 10.1109/TCOM.1963.1088749.

https://ieeexplore.ieee.org/document/1088749
12. L. Huang, Y. Chen and H. Huang, "Research of Digital Communication System," 2020 IEEE Conference on Telecommunications, Optics and Computer Science (TOCS), 2020, pp. 257-260, doi: 10.1109/TOCS50858.2020.9339741. https://ieeexplore.ieee.org/document/9339741

Topics related to development of “FOUNDATION SKILLS”: Various components of digital communication
Topics related to development of “EMPLOYABILITY SKILLS”: Modulation Schemes
Topics related to development of “ENVIRONEMENT AND SUSTAINABILITY”: Operating frequency, Radiation and Bandwidth
Topics related to development of “ENTREPRENEURSHIP”: base-band binary transmission, modulation techniques

Catalogue prepared by	ARUNA M
Recommended by the Board of Studies on	BOS NO: 12th, BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/22

Course Code: ECE3012	**Course Title: Information Theory and Coding** **Type of Course: Program Core Basket** **Theory only**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Basic concepts of simple Applied Statistics [MAT1003], Digital Communication [ECE3007]Mean and variance of discrete random variables, Joint probability, Probability theory** **Basic communication block diagram and its working, Channels**				
Anti-requisites	NIL				
Course Description	**The course is designed for undergraduate level students to learn about information coding in communication. The main objective of the course is to understand the basics of error control coding in the information. This course will be foundation for advanced signal processing and network security. The research potential of the subject can make students to learn and develop algorithm. This course provides an introduction to the concept of Entropy, rate of information and various source encoding algorithms. Discrete & continuous communication channels are included to get the knowledge of numerical computations in the development of communication system without any error.**				
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. Discuss the concept of dependent and independent source, measure of information, Entropy, rate of information and order of a source.** **2. Apply the information source using Shannon encoding, Shannon Fano, encoding and Huffman encoding algorithms.** **3. Analysis of the continuous and discrete communication channels using input, output and joint probabilities.** 4. **Analysis of a code word comprising of the check bits computed using linear block codes, cyclic codes and convolutional codes.**				
Course Content					
Module 1	**Introduction to Information Theory**	Assignment/Quiz	Numerical/ Memory recall based		**10 Classes**
Topics Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources.					
Module 2	**Information Coding**	Assignment	Numerical		**9 Classes**
Topics Source coding theorem, Kraft McMillan Inequality property – KMI, Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding					
Module 3	**Information Channel**	Quiz/ Assignment	Memory recall based / Numerical		**10 Classes**

Topics

Communication Channel block diagram, Channel Matrix, Joint probability Matrix, Mutual Information, Channel Capacity, Channel Capacity of : Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Continuous Channels: Shannon's Hartley law and its numerical.

Module 4	**Error Control Coding**	Quiz/ Assignment	Memory recall based / Numerical	**10 Classes**

Topics

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities ofLinear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.

List of Laboratory Tasks:

NA

Targeted Application & Tools that can be used:

Application area of Information Theory and Coding in Network Security and Computer Communication System.

Professionally used software : MATLAB

Project work/Assignment:

1. **CASE STUDY:In a facsimile transmission of picture, there are about 3x10 6 pixels in one frame. For a good reproduction, 16 brightness levels are found to be necessary. Assuming all these levels to occur equally likely, determine the rate of information transmission if 1 picture frame is to be transmitted every 2 minutes.**
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. Find the relationships between Hartley's, nats and bits.
5. **Project Assignment:** A black and white TV picture consists of 526 lines of picture information. Assume that each line consists of 526 picture elements (pixels) and that each can have 255 brightness levels. Picture is repeated at the rate 30 frames/sec. Calculate the average rate of information conveyed by a TV Set to a viewer.
6. **Assignment 1:** Design an encoder using Shannon's encoding algorithm for a source having six symbols and probability statistics P= {1/2, 1/4, 1/8, 1/16, 1/32, 1/32}.
7. Consider a source with 8 alphabets A to H with respective probabilities of {0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, and 0.02} Construct a binary compact code and determine coding efficiency using Huffman coding algorithm.
8. **Assignment 2:** In a linear block code the syndrome is given by:
   i. S1=r1+r2+r3+r5
   ii. S2=r1+r2+r4+r6
   iii. S3=r1+r3+r4+r7
   Find: (i) Generator matrix (ii) Parity check matrix (iii) code word for all the messages (iv) Find syndrome for the received data 1011011

Text Book(s):

1. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996.
2. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007

Reference(s):

1. Digital Communications – Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058.
2. Information Theory and Coding-by Dr. J. S. Chitode Technical Publications,First edition 2021.

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

1. Video lectures on" Source coding theorem" by Prof: SN Merchant, IIT Bombay https://nptel.ac.in/courses/117101053
2. Videos on Entropy, Mutual Information, Conditional and Joint Entropy https://www.digimat.in/nptel/courses/video/108102117/L02.html
3. Presidency University Library Link https://presiuniv.knimbus.com/user#/home

E-content:

1. Ye Liu, Justin P. Coon"Mitigating Bit-Synchronization Errors in Huffman-Coding-Aided Index Modulation" IEEE Communications Letters (Volume: 23, Issue: 3, March 2019) https://ieeexplore.ieee.org/document/8588988/authors#authors
2. Shigeaki Kuzuoka, Shun Watanabe "An Information-Spectrum Approach to Weak Variable-Length Source Coding With Side-Information" IEEE Transactions on Information Theory (Volume: 61, Issue: 6, June 2015) **Page(s):** 3559 – 3573. https://ieeexplore.ieee.org/document/7089269
3. Distributed Source Coding Using Abelian Group Codes: A New Achievable Rate-Distortion Region,Dinesh Krithivasan;S. Sandeep Pradhan,IEEE Transactions on Information TheoryYear2011,Volume: 57, Issue: 3,Journal Article, Publisher: IEEECited by: Pages (44) https://ieeexplore.ieee.org/document/5714261
4. Aleksandar Radonjic "Integer Codes Correcting Single Errors" IEEE Communications Letters (Volume: 22, Issue: 1, January 2018,**Page(s):** 17 - 20 https://ieeexplore.ieee.org/document/8055561

Topics relevant to development of "FOUNDATION SKILLS" : Communication system and channels
Topics relevant to "HUMAN VALUES AND PROFESSIONAL ETHICS": Designing an error free communication system.

Catalogue prepared by	Ms. Akshatha K
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3013**	**Course Title: Antenna and Wave Propagation** **Type of Course: Data Transfer Technologies Basket** **Theory**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basic concepts of Cartesian, cylindrical and spherical coordinate systems. Differential length (dl), surface (ds) and volume (dv). Line, surface and volume integrals. Divergence and curl operations. Fundamentals of static electric and magnetic fields which includes electric field density and intensity, magnetic field density and intensity, Maxwell's equations, boundary conditions.				
Anti-requisites	**NIL**				
Course Description	This course will introduce the basics of electromagnetic radiation and propagation and also deals with how VHF and UHF antennas are used in microwave communication. This course gives a comprehensive coverage of a wide variety of antennas and propagation techniques related to numerous communication systems. This course provides an opportunity to validate the concepts of mathematical modeling behind the antenna design.				
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques				
Course Outcomes	On successful completion of the course the students shall be able to: 1. Describe the fundamental parameters and Radiation Pattern of Different Types of Antennas. 2. Explain the working and design of VHF, UHF and Microwave Antennas 3. Outline how the electromagnetic wave is propagates in different atmospheric conditions as a ground, space, sky wave.				
Course Content:					
Module 1	Fundamentals of Antenna parameters	Assignment	Memory Recall based Quizzes		**11 *Sessions***
Topics: Introduction, Basic radiation Equation, Radiation Pattern., Beam Area, Beam Efficiency, Radiation Power density, Field Regions, Radiation Intensity, Directivity and Gain Bandwidth, Antenna Apertures, Front to back ratio, Friis Transmission formula, Antenna Theorems.					
Module 2	Basic antenna Design	Assignment / Quiz	Design and analysis of parameters (simulation)		**10 *Sessions***
Topics: Long wire And V antennas, Rhombic Antenna, Folded Dipole Antenna, Yagi Uda Antenna, Helical Antenna, and Horn Antennas. Micro strip Antennas, Reflector Antennas, Cassegrain Antenna, Feed methods of Parabolic Reflectors, Frequency independent Antennas.					
Module 3	Wave Propagation	Assignment	Memory Recall based Quizzes		**12 *Sessions***
Topics: Wave Propagation- Introduction, Ground wave Propagation, Classification of Electromagnetic Waves, Reflection of Radio waves by earth surface. Space wave Propagation- considerations, Tropospheric propagation, Sky wave propagation- structure of ionosphere, Propagation of radio waves through ionosphere. Mechanism of wave bending and critical frequency. MUF, skip distance, Relation between MUF and skip distance.					

Module 4	ANTENNA ARRAYS	Assignment	Memory Recall based Quizzes	12 *Sessions*

Topics
Electronic band gap structure and applications, Antenna Measurements-Test Ranges, Measurement of Gain, Radiation pattern, Polarization, VSWR, N element linear array, Pattern multiplication, Broadside and End fire array – Concept of Phased arrays, Adaptive array, Basic principle of antenna Synthesis-Binomial array

Targeted Application & Tools that can be used:

This course is contributed for placement in core companies, research & development work and also useful to know the existing & developing communications.
Professionally Used Software: MatLab.

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 .**

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:- Designing/simulate a practical antenna (Reconfigurable antennas are preferable) from own specifications.

Text Books:

1. Antennas and wave propagation – John D. Kraus and Ronald J. Marhefka and Ahmad S.Khan, TMH, New Delhi, 5th Ed., (special Indian Edition), 2017

2. Antenna Analysis and Design , Constantine A. Balanis, Wiley Publications, 4th Ed, 2016.

Reference Books:

1. Antenna Theory and Design, Warren L. Stutzman, Gary A. Thiele, Wiley Publications, 3rd Edition.

2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 2000.

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

1. https://youtube.com/playlist?list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT
2. https://www.sciencedirect.com/topics/engineering/radio-wave
3. https://www.sciencedirect.com/topics/physics-and-astronomy/wave-propagation
4. Presidency University Library Link https://presiuniv.knimbus.com/user#/home

E-content:

1. Zhe Chen, Xiao-Ting Yuan, Jian Ren, Tao Yuan, An ultra-wideband MIMO antenna for 5G smartphone, AEU - International Journal of Electronics and Communications, Volume 154, 2022, 154301, ISSN 1434-8411,
https://doi.org/10.1016/j.aeue.2022.154301.

2. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411,
https://doi.org/10.1016/j.aeue.2021.154083.

3. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411,
https://doi.org/10.1016/j.aeue.2021.154083.

4. Xiaokun Yang, Linwei Cui, Zhao Ding, Zhengping Zhang, A 5G filtering antenna simultaneously featuring high selectivity and band notch, AEU - International Journal of Electronics and Communications, Volume 153,
2022, 154299, ISSN 1434-8411,

https://doi.org/10.1016/j.aeue.2022.154299.	
Topics related to development of “FOUNDATION”: VHF and UHF Antenna design and wave propagation. Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: Wave Propagation	
Catalogue prepared by	Mr G tirumala vasu Dr Puneeth
Recommended by the Board of Studies on	BOS NO: 15 th. BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 03/08/22

Course Code: ECE3014	**Course Title:** Micro Controller Applications **Type of Course:** Discipline Elective; Theory & Integrated Laboratory	**L - P - C**	**3**	**2**	**4**
Version No.	**2.0**				
Course Pre-requisites	Basics of Electronics Devises, Logic Design, 8 bit/16 bit Microprocessor Architecture and Assembly Language Programing, Basics of C-Language, Memory types.				
Anti-requisites	**NIL**				
Course Description	**The course provides insights into the fundamentals of microcontroller. The course imparts basic knowledge for Embedded Systems Design. The course develops programming skills in both assembly language and middle level languages. The comprehensive nature of the course covers assembly language programming using simulation tools.** The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real-world problems in order to provide a solution using various simulation tools and hardware interfacing techniques.				
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) Develop assembly language programming problems using coding and debugging skills. 3) Interpret ALP/C program to realize various arithmetic and logical operations that can be carried in an ALU unit using instruction set. 4) Demonstrate basic operations and Analyze the 8051 C Microcontroller interfacing with external hardware. 5) Apply Timer-programming instructions to generate different timing signal, also use it as synchronizing factor in serial communication. 6) Understand the difference between Microcontrollers and ARM controller in terms of instruction set and processing.				
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. Assembler directives					
Module 2	**8051 Instruction Set:**	**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 Stack, I/O Port Interfacing and Programming: Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops - Delay subroutine with simple ALP programs.

Module 3	**8051 Timers and Serial Port:**	**Assignment**	**Programming and Simulation task using C**	**8 Sessions**

Topics:

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 4	**Introduction to ARM**	**Assignment**	**System Design Task and Analysis**	**08 Sessions**

Topics:

ARM INTRODUCTION: ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

List of Laboratory Task:

Experiment 1: Data Transfer - Block move, Exchange, Finding largest element in an array

Level 1: Write an ALP for data transfer with blocks.

Level 2: Write an ALP for to find the largest element in an array.

Experiment 2: Arithmetic Instructions - Addition/subtraction, multiplication and division– (8 bits Arithmetic operations.

Level 1: Write an ALP for addition/subtraction.

Level 2: Write an ALP for multiplication program using successive addition.

Experiment 3: Counters

Level 1: Write an ALP for decimal, hexadecimal up/down counter.

Level 2: Write an ALP for mod 7 counter.

Experiment 4: Boolean & Logical Instructions (Bit manipulations)

Level 1: Write an ALP to use Boolean and logical instructions in a specific Boolean expression of 3 variables.

Level 2: Write an ALP for checking the status of AC flag and C flag and indicate whether data is going out of range.

Experiment 5: Code conversion: HEX - Decimal and Decimal – HEX, BCD- ASCII

Level 1: Write an ALP for decimal to Hexadecimal conversion.

Level 2: Write an ALP for conversion of Hexadecimal to Binary.

Experiment 6: External LCD interface to 8051

Level 1: Write a C program for LCD Display of “ECE”

Level 2: Write a C program for scrolling display.

Experiment 7: Generate different waveforms Square, Triangular using DAC interface to 8051 change the frequency and amplitude.

Level 1: Write a C program for generating square wave.

Level 2: Write a C Program for generation of staircase waveform with logic 0 as 0 volts as logic 1 as 5Volts.

Experiment 8: Stepper motor to rotate clockwise and anti-clock wise control interface to 8051

Level 1: Write a C program for stepper motor for clockwise rotation.

Level 2: Write a C program for rotating motor 3 times clock and 2 times anticlockwise.

Targeted Application & Tools that can be used

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 ARM 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:
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):

1) "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.

2) Introduction to ARM cortex microcontroller – Jonathan W Valvano, Createspace Independent Publishing Platform; 2nd ed. Edition.

References:

Reference Book(s):

1) "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.
2) "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.
3) "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

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

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
4. 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	Mr. Syed Abrar Ahmed Mr. Tony Aby Varkey M
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

DISCIPLINE ELECTIVES

GENERAL BASKET

Course Code: ECE3015	**Course Title:** Measuring Instruments and Sensors **Type of Course:** Discipline Elective Theory & Integrated Laboratory	**L- P-C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**[1] Linear Integrated circuits-ECE 3001** **Concepts of Instrumentation amplifier, signal conditioning circuits, Oscillators, Behavior of components of Electrical Engineering.** **[2] Digital Electronics-ECE2002** **Concepts of digital system, Combinational circuits**				
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	**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. **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	**13 Sessions**	
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.

Programming Assignment

Module 2	Storage and display devices	Assignment/quiz	Data collection and simulation task	**12 Sessions**

Topics:
Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

Simulation based assignment

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

Topics:
Passive Sensors Resistive Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Light-dependent Resistors (LDRs), Resistive Hygrometers, Capacitive Sensors: Variable capacitor, Differential capacitor, Inductive Sensors: Reluctance variation sensors, Eddy current sensors

Simulation based assignment

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

Project work/Assignment:

Project Assignment1: FIRE RESCUE SYSTEM IN RAILWAYS USING LABVIEW
Project Assignment2: Test platform for Pump Controller.
Project Assignment3: Line Following Robot.
Project Assignment4: Low-Cost Experimental Setups for Mid-Air 3D Reconstruction.
Project Assignment5: Design of Small Photovoltaic (PV) Solar-Powered Water Pump System.
Assignment 1:Write a matlab code for the linearity property ,mean, variance
Assignment 2:Summarize about various techniques of oscilloscopes
Assignment 3: Measurement of amplitude, frequency, THD of an external signal using NI my DAQ and Lab-VIEW
Assignment 4: Smart sensor as an intelligent devices.
Assignment 5: Telecommunications reliability monitoring using wireless MEMS.
Assignment 6: Measurement of unknown resistance using Wheatstone bridge using Lab View.
Assignment 7: Measurement of unknown inductance using Maxwell's inductance bridge using Lab View.
Assignment 8: Measurement of temperature using RTD , NI my-DAQ and Lab-VIEW

***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. **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 related to development of "FOUNDATION SKILLS": Direct and Indirect Methods, Digital voltmeter, digital Multimeter, cathode ray oscilloscope, Resistive, capacitive transducers, LVDT, Single and Multi-channel DAS, Amplifiers, Timers, Familiarization with virtual instrumentation using Lab VIEW Software

Catalogue prepared by	**Dr. Ajit Kumar**
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3016</td><td colspan="4">Course Title: Electronic Controlled Converter

Type of Course:
Program Core & Theory only</td><td>L- P- C</td><td>3</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">The knowledge of analog electronics and microcontroller are needed to design the power converter and associated control circuit; Network Theorems for voltage and current calculation in power converter topologies.</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 learn about the basics of power semiconductor devices, design of variety of power electronic converters and associated control algorithms for the control and conversion of one form of energy into another form of energy. The nature of the course is application oriented. The course benefits the students through assignment projects based on practical implementation of various power converters which will be useful in domestic and industrial applications.</td></tr>
<tr><td>Course Objectives</td><td colspan="8">This course is designed to improve the learners' EMPLOYABILITY SKILLS by Experiential 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 features, principles and characteristics of power semiconductor devices.
2] Demonstrate the working of AC to DC controlled power converters.
3] Illustrate the operation of DC to DC power converters.
4] Sketch DC to AC power converters.
5] Show the working of AC to AC power converters.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to power electronics</td><td>Assignment</td><td colspan="2">Control characteristics of power semiconductor devices</td><td colspan="2">06 Sessions</td></tr>
<tr><td colspan="9">Topics:
Introduction to power electronics (definition, block diagram, applications), various power semiconductor devices, control characteristics of recent/most important power semiconductor devices.</td></tr>
<tr><td>Module 2</td><td colspan="2">AC to controlled DC power converters</td><td>Assignment</td><td colspan="2">Simulation of AC to controlled DC power converter (Full bridge controlled)</td><td colspan="2">10 Sessions</td></tr>
<tr><td colspan="9">Topics:
Introduction to AC to controlled DC converter, single phase full bridge controlled converter, gating pulse generation, isolation and gate drive circuits.</td></tr>
</table>

Module 3	DC to DC power converter	Assignment	Simulation of DC to DC power converter	**10 Sessions**
Topics: **Introduction to DC to DC converter, Buck converter, Boost converter, Bi-directional converter, Fly-back converter, PWM pulses generation, isolation and gate drive circuits.**				
Module 4	DC to AC power converter	Assignment	Simulation of DC to AC power converter	**09 Sessions**
Topics: **Introduction to DC to AC converter, single phase full-bridge inverter, square pwm and sine pwm, filter selection, isolation circuit and gate drive circuits.**				
Module 5	AC to AC power converter	Assignment	Simulation of AC to AC power converter	**09 Sessions**
Topics: **Introduction to AC to AC converter, single phase bi-directional AC voltage controller using TRIAC, gating signal generation, isolation and gate drive circuits.**				
Targeted Application & Tools that can be used: **Application Area is solar, wind, automotive, domestic and industrial.** **Professionally Used Hardware/Software: Arduino/Raspberry Pi MATLAB/SIMULINK/Arduino/Python**				
Project work/Assignment:				
1.Case Studies: At the end of the course students will be given a 'real-world' application based topics like controlled rectifiers, choppers, inverters 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 Assignment: Software/Hardware implementation of few important power converters studied in this course** **Assignment-1: AC to Controlled DC power converter using SCR and display the output DC voltage on LCD using Arduino controller** **Assignment-2: Fixed DC to Variable DC power converter (Step-down DC-DC converter) using IGBT and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller** **Assignment-3: Fixed DC to Variable DC power converter (Step-up DC-DC converter) using IGBT and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller** **Assignment-4: Fixed DC to DC to multiple DC power converter (Isolated Fly-back converter) using Power MOSFET and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller** **Assignment-5: AC to Controlled AC power converter (Bidirectional AC voltage controller) using TRIAC and associated components and display the output AC voltage on LCD using Arduino**				

controller

Assignment-6: Fixed DC to AC power converter (Full Bridge Inverter) using power MOSFET and associated components and display the input DC voltage and output AC voltage on LCD using Arduino controller

Text Book(s)

1. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India Pvt. Ltd., /Pearson (Singapore -Asia) New Delhi, 2nd Edition, 2002

2. Ned Mohan, T. M. Undeland, W. P. robbins "Power Electronics: Converters, Applications and Design", John-Wiley, 3rd Edition, 2007

Reference(s):

Reference Book(s):

1. M. D. Sing and Khanchandani K. B, "Power Electronics", TMH Publishing Company Limited, 2001.

2. Cyril W. Lander, "Power Electronics", McGraw Hill, 3rd Edition, 1993.

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

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

E-content:

13. D. Fewson, "Introduction to power electronics," in IEEE Power Engineering Review, vol. 19, no. 9, pp. 44-44, Sept. 1999, doi: 10.1109/MPER.1999.785806. https://ieeexplore.ieee.org/document/785806
14. P. Nicolae, I. Nicolae and M. Motocu, "Behavior of a fully controlled rectifier from a power group," Proceedings of 14th International Power Electronics and Motion Control Conference EPE-PEMC 2010, 2010, pp. T11-99-T11-106, doi: 10.1109/EPEPEMC.2010.5606513. https://ieeexplore.ieee.org/document/5606513
15. B. Kim, E. Boulaud, E. Boisaubert, S. Am and P. Chrin, "Study of the Control of a New AC Voltage Stabilizer using Linear Controller with Reference Frame Transformation," 2020 22nd European Conference on Power Electronics and Applications (EPE'20 ECCE Europe), 2020, pp. P.1-P.7, doi: 10.23919/EPE20ECCEEurope43536.2020.9215637. https://ieeexplore.ieee.org/document/9215637
16. R. Bououd and L. Sbita, "An overview of chopper topologies," 2017 International Conference on Green Energy Conversion Systems (GECS), 2017, pp. 1-7, doi: 10.1109/GECS.2017.8066207. https://ieeexplore.ieee.org/document/8066207
17. R. Billmeyer, M. Lu, B. Johnson and S. Dhople, "Modeling and Simulation of Power-Electronic Inverters in Analog Electronic Circuit Simulators," 2021 IEEE International Symposium on Circuits and Systems (ISCAS), 2021, pp. 1-5, doi: 10.1109/ISCAS51556.2021.9401268. https://ieeexplore.ieee.org/document/9401268

Topics related to development of "FOUNDATION SKILLS": Various power semiconductor devices and Power Converters.

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Power Converters.

Catalogue prepared by	Dr. Sreenivasappa B V
Recommended by the Board of Studies on	BOS NO: 10th BOS held on 17/01/2020
Date of Approval by the Academic Council	Academic Council Meeting No. 16th, Dated 23/10/2021

Course Code: ECE3017	**Course Title: Linear Algebra for Communication Engineering** **Type of Course: Discipline Elective from General Basket & Theory only**		**L- P- C**	3	0	3
Version No.	2.0					
Course Pre-requisites	To succeed in this course the student should be comfortable with vectors, matrices and their operations.					
Anti-requisites	NIL					
Course Description	The course emphasizes on 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.					
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) **Develop** the algebraic methods essential for the study of systems of linear equations, matrix algebra, vector spaces. (Comprehension) 2) **Apply** the concepts of determinants and eigenvalues to discriminate between invertible and non-invertible matrices for diagonalization and orthogonalization. (Application) 3) **Execute** linear transformations of finite dimensional vector spaces to compose their matrices in specific bases. (Application)					
Course Content:						
Module 1	Matrices and Gaussian Elimination	Assignment	Programming (Curve Fitting) Task	**10 Sessions**		
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.						
Module 2	Least squares, Determinants and Eigenvalues	Assignment	Programming Task	**10 Sessions**		
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.						
Module 3	Positive Definite Matrices and Applications	Project Assignment	Programming and Simulation Task	**14 Sessions**		
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.						
Module 4	Optimization	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

Project work/Assignment:

Project Assignment: Use computer graphics to visualize Eigen Vectors and perform SVD in creating an orthogonal space for a real-life application of your choice. A final report and presentation are required.
Assignment 1: Collect a set of data points and a find a polynomial that fits best to it.
Assignment 2: Perform Gram-Schmidt process to create a M-ary encoding system.

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

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

Topics relevant to development of "FOUNDATION SKILLS": Solution to homogenous equations, Basis and Dimensions, the four fundamental sub-spaces.

Topics relevant to development of "EMPLOYABILITY": Linear transformations and their matrices, Singular Value Decomposition.

Catalogue prepared by	**Dr. Sumantra Chaudhuri**
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th, Dated 3/08/2022

Course Code: ECE3018	**Course Title:** Engineering Applications using Software Tools **Type of Course: Discipline Elective/ Theory**		**L- P- C**	3	0	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 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	**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) 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

Project work/Assignment:

Assignment 1: Find the Laplace Transform of the given time function. Then find the inverse Laplace transform. Verify your result using symbolic math in MATLAB

Assignment 2: Create a VI to find the factorial using a while loop and for loop

Assignment 3: Interface a common cathode seven segment display to display the numbers in your ID using 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.):

14. Video lectures on various courses available online in MATLAB
    https://www.matlabacademy.mathworks.in

E-content:

22. 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

23. 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

24. 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

25. 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 development of "EMPLOYABILITY": Introduction to Data Acquisition and Sampling Theory, Filtering Signals, Digital Thermometer, DC motor speed control. Interfacing certain sensors and display devices using myDAQ.

Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Diana Steffi Mr. Sunil Kumar Dasari Mr. Kiran Kale

Recommended by the Board of Studies on	9th BOS held on 04/05/2019
Date of Approval by the Academic Council	Meeting No. 11th , Dated 11/06/2019

<table>
<tr><td>Course Code:
ECE3019</td><td colspan="3">Course Title: Python Programming for Electronics Applications
Type of Course: Discipline Elective, General Basket
Theory only</td><td>L-P-C</td><td>3</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">Fundamentals of python programming and basics of electronics such KVL, KCL, modulation techniques, transistors</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 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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE 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) 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</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals of Python Programming</td><td>Assignment/ Quiz</td><td colspan="2">Programming and simulation Task</td><td>12 Sessions</td></tr>
<tr><td colspan="8">Topics:
Variables, Conditional Statement, Boolean expressions, If/Else statement, Loops, Functions, Objects, Lists, Files , Classes</td></tr>
<tr><td>Module 2</td><td colspan="2">Circuit Simulation</td><td>Assignment / Quiz</td><td colspan="2">Programming and Simulation task</td><td>12 Sessions</td></tr>
<tr><td colspan="8">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,</td></tr>
<tr><td>Module 3</td><td colspan="2">Signal Processing Using Python</td><td>Assignment / Quiz</td><td colspan="2">Programming and Simulation task</td><td>15 Sessions</td></tr>
<tr><td colspan="8">Topics:
Python programming for Continuous time signal processing, Discrete time signal processing, Perform Convolution of two sequences, correlation, FFT, Filters using python</td></tr>
</table>

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.

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. **Case Studies**: At the end of the course students will be given an application-based circuit, like Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include the Working Code and Results etc. in appropriate format.

Text Book(s):

4. J. V. Guttag," Introduction to computation and programming using python: with applications to understanding data". PHI – 2016
5. 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.):

15. 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 related to development of "FOUNDATION": ": Variables, Conditional Statement, Boolean expressions, If/Else statement, Loops, Functions, Objects, Lists, Files, Classes
Topics related to development of "EMPLOYABILITY": Circuit Simulation
Topics related to development of "ENTREPRENEURSHIP":
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY":
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS":

Catalogue prepared by	Mrs. Kehkeshan Jalall S
Recommended by	**BOS Meeting NO: 12th, Dated BOS 10/08/2021**

the Board of Studies on	
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE3020	**Course Title:** **Computational Intelligence and Machine Learning** **Type of Course:** **Discipline Elective General Basket** **Theory**	**L- P-C**	3	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	This course is designed to improve the learners' **EMPLOYABILITY SKILLS** by using **EXPERIENTIAL LEARNING** techniques using modern Tools.				
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

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 .**

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 computational and machine learning l using Python/ MATLAB.

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 related to development of “SKILL”: Applications of Machine Learning in data analysis.
Topics related to development of “EMPLOYABILITY”: Data classification, Regression.
Topics related to development of “HUMAN VALUES AND PROFESSIONAL ETHICS”: computational intelligence algorithms.

Catalogue prepared by	Mr. G Tirumala Vasu
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: **ECE 3021**	**Course Title: Optoelectronic Materials** **Type of Course:** **General Basket & Theory only**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**[1] Elements of Electronics Engineering (ECE1001) and** **[2] Physics (PHY1002)** **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 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** 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**	Assignment/quiz	Programming & Simulation task	**14 classes**	

	Optical Detection Devices			

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

Project work/Assignment:

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: Adding an LCD and keypad to a tachometer and speedometer

Assignment: 1 Quantum Dots of Gallium and Indium Arsenide Phosphides: Opto-electronic Properties, Spin Polarization and a Composition Effect of Quantum Confinement

Assignment 2: Optoelectronic techniques for the generation and detection of terahertz waves

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:

18. Manufacturing of Er**3** +-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.
19. 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.
20. 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.
21. 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 development of “EMPLOYABILITY SKILLS”: Display Devices, Lasers and Optical Detection Devices.
Topics relevant to development of “ENVIRONMENT AND SUSTAINABILITY”: Various detector devices

Catalogue prepared by	Dr. Pritam Keshari Sahoo
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3022	**Course Title: Fundamentals of Photonics** **Type of Course: Elective Theory**.	**L- P-C**	3	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		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	**8 sessions**

				assignments	

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.**

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-wavelen contrast grating VCSELs and comparison with experiment," *CLEO:* 2013.**https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6833068&isnumber= 2.**
2. Guan-Lin Su, Pengfei Qiao, C. -Y. Lu, D. Bimberg and S. L. Chuang, "Low-threshold dielectr microlasers," *2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to A Applications*, 2014, pp. **https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6990118&isnumber=6988**
3. Weik, M.H. (2000). integrated fiber optic communications system. In: Computer Scien 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 Commun 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 K A
Recommended by the Board of Studies on	BOS NO: 12 th. BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 3/08/2022

Course Code: ECE3023	**Course Title: Wireless Sensor Networks and IOT** **Type of Course: Discipline Elective, General Basket Theory only**		**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Digital Communication, Computer Networks**				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to enable the students to appreciate the fundamentals of Internet of Things and Wireless Sensor Networks (WSN) and various middleware protocols for IOT and WSN. The IOT and WSN are cutting-edge technologies which are popularly used in many areas like industrial automation, biomedical engineering, etc. These areas have great potential for research. This course will enable students to understand IOT and WSN applications and various middleware protocols in implementation.**				
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) **Understand** the architecture of IOT and WSN systems 2) **Explore** various middleware protocols for building IOT and WSN applications 3) **Illustrate** real time applications of IOT and WSN to make smart world 4) **Discover** competence in programming for IoT Applications.				
Course Content:					
Module 1	Introduction to WSN	Quiz	Memory Recall based Quizzes	**09 session**	
Topics: Introduction and background on WSN Technology, Basic Sensor Network Architecture, Examples of WSN in various categories, Sensor Node Technology, WSN Operating Environment, WSN Trends					
Module 2	WSN Middleware	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**12 session**	
Topics: Generic protocol stack for WSN, MAC Protocols for WSNs, Sensor-MAC Case Study, Data Dissemination and Gathering, WSN Routing Techniques, Flooding, and Its Variants, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gatherin34g in Sensor Information Systems, WSN and internet communication.					
Module 3	Introduction to IOT	Assignment	Programming Assignment	**12 session**	
Topics: Introduction to IOT Technology, IOT VS WSN, Simplified IOT architecture, Functional blocks of an IoT ecosystem, Physical design of IoT, IoT enabling technologies, Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open-source hardware's, Examples of IoT infrastructure					
Module 4	**Prototyping and Designing Software for IoT Applications:**	Assignment	Programming Assignment	**12 session**	
Topics:					

Introduction, Prototyping Embedded device software, Programming Embedded Device Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development. Programming MQTT clients and MQTT server. Introduction to IoT privacy and security. Vulnerabilities, security requirements and threat analysis, IoT Security Tomography and layered attacker model.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Industry 4.0, Biomedical and Agricultural automation

Professionally Used Software: Python/ MATLAB

Project Work/Assignment:

1. Case Study: At the end of the course students will be given a 'real-world' application-based on IOT and WSN 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

2 Book/Article review: At the end of the course a literature review of any 20 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):

6. Kazem Sohraby, Daniel Minoli, Tajeb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", John Wiley and Sons Inc, 1st Edition.
7. Arshdeep Bahga, Vijay Madisetti,"Internet of Things: A Hands-on-Approach", VPT Publications, 1st Edition.
8. Raj Kamal, "Internet of Things-Architecture and design principles", McGraw Hill Education.

Reference(s):

Reference Book(s):

1. Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", Wiley-IEEE Press, USA, 1 st edition
2. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons, 1 st edition
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", A press Publications, 1st Edition
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.

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

E-content:

26. Andrea Zanella; Nicola Bui; Angelo Castellani; Lorenzo Vangelista; Michele Zorzi , and Antonis Argyros, " Internet of Things for Smart Cities ", IEEE Internet of Things Journal , VOL. 1, issue.1 https://ieeexplore.ieee.org/document/6740844
27. John A. Stankovic," Research Directions for the Internet of Things", IEEE Internet of Things Journal

<table>
<tr><td colspan="2">, VOL. 1, issue.1
https://ieeexplore.ieee.org/document/6774858
28. Mohammad Abdur Razzaque; Marija Milojevic-Jevric; Andrei Palade; Siobhán Clarke, Middleware for Internet of Things: A Survey", IEEE Internet of Things Journal , VOL. 1, issue.1
https://ieeexplore.ieee.org/document/7322178
29. C. Arcadius Tokognon; Bin Gao; Gui Yun Tian; Yan Yan, “ Structural Health Monitoring Framework Based on Internet of Things: A Survey”, IEEE Internet of Things Journal , VOL. 1, issue.1
https://ieeexplore.ieee.org/document/7842584</td></tr>
<tr><td colspan="2">Topics relevant to the: “FOUNDATION SKILLS”, Introduction and background on WSN Technology, Introduction to IOT Technology, IOT VS WSN

Topics relevant to the:” EMPLOYABILITY”, Cellular IoT, Industrial IoT (IIOT), Medical IOT (IOMT), Industry 4.0 and IoT.</td></tr>
<tr><td>Catalogue prepared by</td><td>Mr. Kiran Dhanaji Kale</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS 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 03/08/2022</td></tr>
</table>

Course Code: ECE3024	**Course Title:** **Data Acquisition Techniques** **Type of Course:** **Discipline Elective Theory**	**L- P- C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**Fundamentals of Electronic Circuits, Sampler, Quantizer, Encoder and Decoder.**				
Anti-requisites	**NIL**				
Course Description	**The purpose of the course is to introduce the students to the fundamental data acquisition principles and data conversion. The nature of the course is to provide the knowledge of acquiring the data from transducers/input devices, their interfacing and instrumentation systems. The students will capture real-time data using sensors, process and analyze the data for developing real-world applications.**				
Course Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using** data acquisition methods for different signal conditioning systems.				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Identity** the elements of a data acquisition system. 2. **Describe** different forms of signal conditioning methods using operational amplifiers. 3. **Discuss** the elements of Analog to Digital conversion and Digital to Analog conversion systems. 4. **Explain** various types of data transfer protocols.				

Course Content:

Module 1	Data Acquisition Overview	Quiz	Memory recall	**8 Sessions**
Topics: Sensor Types Overview, Application Areas and Trends, LabVIEW Introduction, System Components, Signal Characteristics, Signal Conditioning, Signal Source and Measurement System Configuration, Analog and digital data acquisition, Sensor/Transducer interfacing, Sample and hold circuits, Interference, Grounding and Shielding				
Module 2	Principles of PC based Data Acquisition and Data Acquisition using GPIB	Assignment/quiz	Numerical/Simulation	**10 Sessions**
Topics: Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits. Interpolation, PC-bus based data acquisition system, Analog and digital isolation, Types of sampling, Data transfer methods, Data acquisition configurations, Expansion buses and I/O ports, Local data acquisition: Plug-in data acquisition, Parallel port data acquisition				
Module 3	Data Transfer Techniques and Data Acquisition System (DAS)	Assignment/quiz	Numerical/ simulation task	**10 Sessions**
Topics:				

Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, IEEE1394, LAN, Universal serial bus, HART protocol, Foundation Fieldbus, ModBus, Zigbee and Bluetooth.
Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system.

Module 4	Networked Data Acquisition, DCS and SCADA System, Programmable Logic Controller	Assignment	Data collection and analysis Task	**12 Sessions**

Hierarchy model for industrial automation, Network data communication: Analog communication, Hybrid communication, Digital communication, Local area networks, OSI model, LAN characteristics, LAN types, Internet protocol, Network devices, HART communication, Network connection, Communication modes.
DCS and SCADA system: DCS hardware and software, DCS structure, Representative DCS, SCADA hardware., Software Programmable Logic Controllers, Parts of PLC, Operation of PLC, Symbols used in PLC realization, Difference between PLC, Hardwired System and Computer, Relay Logic and ladder logic, Ladder commands, PLC timers and counters, Recent developments.

Targeted Application & Tools that can be used:

Application Area - Speech communication, Data Science, Image Processing, Bio-medical Signal processing, VLSI based signal processing. The students will be able to join instrumentation industries.
Professionally Used Software/Hardware: MATLAB/ NI LabVIEW
Besides these software tools hardware equipment such as NI ELVIS II+ Workstation, NI myDAQ etc., can be used to perform testing and analysis.

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a 'real-world' applications like SCADA, Process Control Systems etc. 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 Assignments:
Project Assignment1:
Design of differential amplifier and instrumentation amplifier:
Build a sensor bridge circuit using Multisim, having 1kΩ elements and sensitivity of 10mV/V with 5V excitation circuit.
At full scale, sensors in the bridge exhibit 1% change in resistance value. Design the following amplifier circuits so that the full scale output of the amplifier is 5V.
i) Single op amp differential amplifier.
ii) Three op amp instrumentation amplifier.
Simulate the above circuits to measure the voltage at its full scale.

Project Assignment2:
Programming with LabVIEW: Signal acquisition and generation:
Create a simple VI that simulates an analog signal and plots it on a waveform graph. The VI will give user control of the frequency and amplitude of this wave. Configure the following DAQ cards: i) NI ELVIS, ii) myDAQ and iii) cDAQ to generate the signal simulated by the simple VI. Also configure the DAQ cards to acquire the generated signal and display it on waveform graph.

Project Assignment3:
Measuring strain, temperature, pressure (various physical parameters) using LabVIEW:

1. Write a MATLAB code for signal conditioning for data accusation system of various sound signals

like speech signals, audio signals, animal sounds etc.
2. Write the MATLAB code for the signal conditioning for image received form data acquisition system.
3. Design the OPAMP based amplifier used for the detection of envelope with particular bandwidth range in cadence/Multisim.
4. Design an alarm system that is to be set off when room temperature exceeds 50o C. Given to you are a temperature-to-voltage- transducer for which 50o C produces a voltage v1 = 5 V. The alarm sounds when -15 V is applied, and it is silent when +15 V is applied.
5. Design a digital-to-analog (DAC) that produces an analog output voltage Vo equal -1 V times the 4-bit number at the input.

TEXT BOOK(S):

1. Data Acquisition and Control Handbook, 1st edition, Keithley, Measurement Computing Corporation, USA

REFERENCE(S):

REFERENCE BOOK(S):

1. **John Park and Steve Mackay, Practical Data acquisition for Instrumentation and Control, 2011, 1st ed., Newness publishers, Oxford, UK.**
2. **Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education1st edition, (2006).**
3. **Kalsi, H.S., Electronic Instrumentation, Tata McGraw Hill (2002), 1st edition.**
4. **Gayakwad, R.A., Op-Amp and Linear Integrated Circuits, Pearson Education 1st edition, (2002).**
5. **Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited 1st edition, (2007).**
6. **Ramon Pallas-Areny and John G Webster, Sensors and Signal Conditioning, 2012, 2nd ed., Wiley India Pvt. Ltd.**
7. **Robert H King, Introduction to Data Acquisition with LabVIEW, 2012, 2nd ed., McGraw Hill, New York.**
8. **Ananad, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited 1st edition, (2004).**
9. **Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited 1st edition, (2006).**

ONLINE RESOURCES (E-BOOKS, NOTES, PPTS, VIDEO LECTURES ETC.):

1. **Online videos of lab-VIEW compatible data acquisition systems.**
2. **Nptel lecture video https://nptel.ac.in/courses/108/105/108105062/"**
3. **https://www.youtube.com/watch?v=nX_Xp2hVc0s**

E-CONTENT

1. A. Mann *et al*., "A sampling ADC data acquisition system for positron emission tomography," in *IEEE Transactions on Nuclear Science*, vol. 53, no. 1, pp. 297-303, Feb. 2006, doi: 10.1109/TNS.2006.869830.
2. J. Xu, A. T. Nguyen, T. Wu, W. Zhao, D. K. Luu and Z. Yang, "A Wide Dynamic Range Neural Data Acquisition System With High-Precision Delta-Sigma ADC and On-Chip EC-PC Spike Processor," in *IEEE Transactions on Biomedical Circuits and Systems*, vol. 14, no. 3, pp. 425-440, June 2020, doi: 10.1109/TBCAS.2020.2972013
3. Prokop, C. J., S. N. Liddick, B. L. Abromeit, A. T. Chemey, N. R. Larson, S. Suchyta, and J. R. Tompkins. "Digital data acquisition system implementation at the national superconducting cyclotron laboratory." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 741 (2014): 163-168.
4. J. Richards, M. Lim, G. Li, E. Araya and Y. Jia, "Continuous ECG Monitoring with Low-Power Electronics and Energy Harvesting," 2020 IEEE 63rd International Midwest Symposium on Circuits and Systems (MWSCAS), 2020, pp. 643-646, doi: 10.1109/MWSCAS48704.2020.9184610.

Topics related to development of "FOUNDATION SKILLS": Data Acquisition with Op-Amps.

Topics related to development of "EMPLOYBILITY": Serial data transmission methods, Data Transfer Protocols. **Topics related to development of "ENVIRONMENT AND SUSTAINBILITY":** Data Transfer Techniques and Data Acquisition System (DAS).	
Catalogue prepared by	Dr. Ashutosh Anand, Mrs. Aruna M, Dr.Azra Jeelani
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3025	**Course Title:** Artificial Intelligence with Python **Type of Course:** General Basket & Theory	**L- P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Introduction to computer science, database management system, probability theory.				
Anti-requisites	**NIL.**				
Course Description	This course on Artificial Intelligence with Python enables the students to acquire programming skills in core Python, Object Oriented Skills, designing Graphical User Interfaces and to write database applications in Python. The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using simulation tools.				
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:** (i) **Explain** basic principles of AI and Python programming language. (ii) **Understand** the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning. (iii) **Implement** object-oriented concepts. (iv) **Implement** database and GUI applications.				
Course Content:					
Module 1	Introduction to Artificial Intelligence	Quiz	Memory Recall based Quizzes	**14 Hours**	
INTRODUCTION TO PYTHON: Python for data science, data visualization in python, data analysis using SQL, advanced SQL and best practices, data analysis in excel, analytics problem solving, math for machine learning, Introduction to Artificial Intelligence, supervised versus unsupervised learning, Classification, Pre-processing data: Binarization; Mean removal; Scaling; Normalization. Label encoding, Logistic Regression classifier, Naïve Bayes classifier, Confusion matrix. Support Vector Machines. Regression.					
Module 2	Predictive Analytics with Ensemble Learning	Assignment/ Quiz	Conceptual Descriptive	**12 Hours**	
Ensemble Learning: Decision Trees, Random Forests and Extremely Random Forests, predicting traffic using Extremely Random Forest regressor. Unsupervised learning: Clustering data with K-Means algorithm, Estimating the number of clusters with Mean Shift algorithm, Estimating the quality of clustering with silhouette scores. Gaussian Mixture Models, building a classifier based on Gaussian Mixture Models.					
Module 3	Building Recommender Systems	Assignment/ Quiz	Programming & Simulation	**8 Hours**	
Creating a training pipeline, Extracting the nearest neighbors, building a K-Nearest Neighbors classifier, Computing similarity scores, finding similar users using collaborative filtering, building a movie recommendation system, Logic programming: Understanding the building blocks of logic programming, solving problems using logic programming.					
Module 4	Reinforcement Learning	Assignment/ Quiz	Case studies	**6 Hours**	
Reinforcement learning versus supervised learning, Real world examples of reinforcement learning, building blocks of reinforcement learning, creating an environment, building a learning agent					
List of Laboratory Tasks:					

Nill

Targeted Application & Tools that can be used:

Employability-

Data Scientist, Principal Data & Applied Scientist Manager, Applied Intelligence, Research Scientist, Business Intelligence Developer, AI Data Analyst, Big data engineering, Robotics Scientist, AI engineer.

TOOLS – Python.

Project work/Assignment:

1.Case Study: How eBay Writes Thousands of Email Subject Lines in Minutes:

We're all familiar with eBay-the online shopping site best known for its consumer-to-consumer, auction-style selling. With billions of products to choose from and millions of customers to serve, eBay was looking for a way to make each customer feel like they were the only person in the world that mattered. Surely email is the way to do that. So, instead of sending cookie-cutter emails to its entire contact list, eBay could just write personalized messages for each of its customers...right? Wrong. It'd have to spend countless resources hiring thousands of copywriters to support that plan. Alternatively, eBay turned to artificial intelligence and tested AI-powered copywriting solution Phrasee. Using natural language generation and deep learning, Phrasee is capable of learning a brand's voice and automatically writing optimized email subject lines, Facebook ads, and push messages. For eBay, this meant training the tool on the company's data and letting it produce thousands of machine-written email subject lines. These personalized subject lines were then A/B tested at scale with eBay's millions of customers-all in the matter of a few minutes

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):

T1: Artificial Intelligence with Python, by Prateek Joshi. Packt Publishing.
T2: Python Machine Learning, by Sebastian Raschka & Vahid Mirjalili, Packt Publishing
T3: Artificial Intelligence with Python Cookbook: Proven Recipes for Applying AI Algorithms and Deep Learning Techniques Using TensorFlow 2.x and PyTorch 1.6, by Ben Auffarth, Packt Publishing

Digital Content:

- **NPTEL:**
  https://nptel.ac.in/courses/106/102/106102220/
  https://nptel.ac.in/courses/106/105/106105077/
- **Coursera:**
  https://www.coursera.org/learn/ai-for-everyone

e-learning materials –

1. Chen, Mu Ku, Xiaoyuan Liu, Yanni Sun, and Din Ping Tsai. "Artificial Intelligence in Meta-optics." *Chemical Reviews* (2022).
2. Baduge, Shanaka Kristombu, Sadeep Thilakarathna, Jude Shalitha Perera, Mehrdad Arashpour, Pejman Sharafi, Bertrand Teodosio, Amkit Shringi, and Priyan Mendis. "Artificial intelligence and smart vision for building and construction 4.0: Machine and deep learning methods and applications." *Automation in Construction* 141 (2022): 104440.
3. Namatherdhala, Bharatwaja, Noman Mazher, and Gopal Krishna Sriram. "A Comprehensive Overview of Artificial Intelligence Tends in Education." *International Research Journal of Modernization in Engineering Technology and Science* 4, no. 7 (2022).
4. Ahmed, Imran, Gwanggil Jeon, and Francesco Piccialli. "From artificial intelligence to explainable artificial intelligence in industry 4.0: a survey on what, how, and where." *IEEE Transactions on Industrial Informatics* 18, no. 8 (2022): 5031-5042.

References: **R1:** Introduction to Machine Learning with Python: A Guide for Data Scientists, by Andreas C. Müller, Sarah Guido, O' Reilly Publishing. **R2:** Python: Beginner's Guide to Artificial Intelligence, by Denis Rothman, Amir Ziai, Abhishek Nagaraja, Ankit Dixit, Matthew Lamons, Rahul Kumar, Packt Publishing.	
Topics related to development of "SKILL": Statistical concepts like Mean, Standard Deviations, and Gaussian Distributions along with probability theory for algorithms like Naive Bayes, Gaussian Mixture Models, and Hidden Markov Models are necessary to thrive in the industry. **Topics related to development of "EMPLOYABILITY":** Python Programming Language	
Catalogue prepared by	Dr. Pritam Keshari Sahoo and Ms. Natya.S
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3026</td><td colspan="3">Course Title : Neural Networks and Deep Learning
Type of Course: Theory</td><td>L- P- C</td><td>3</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">NA</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 teach the major concepts, themes, and algorithm used in contemporary machine learning. The nature of this course is analytical with practical understanding.
The first part of the course focuses the basics of Neural Network and the remaining practice the applications of deep learning by exploring foundational concepts, structuring popular networks and implementing models through modern technologies. The need for Deep learning helps to provide practical knowledge in handling and analyzing real-world applications. The course enhances programming abilities through assignments.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is <u>SKILL DEVELOPMENT</u> of the student by using <u>PARTICIPATIVE 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) Summarize the basics of Neural networks.
2) Illustrate the Convolutional Neural Network
3) Demonstrate the basic concepts of deep learning</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction To Neural Networks</td><td>Quiz and assignments</td><td></td><td colspan="2">10 SESSION</td></tr>
<tr><td colspan="8">Topics: Neural Networks Overview- Types of Neural Networks- Applications of Neural Networks- Advantages of Neural Networks- Disadvantages of Neural Networks-- The Neural Network – Limits of Traditional Computing – Machine Learning – Neuron – FF Neural Networks – Types of Neurons – Softmax output layers- Tensor flow – Variables – Operations – Placeholders – Sessions – Sharing Variables – Graphs – Visualization- Stochastic gradient decent, Curse of Dimensionality. Loss function</td></tr>
<tr><td>Module 2</td><td colspan="2">Convolutional Neural Network</td><td>assignments</td><td></td><td colspan="2">10 SESSION</td></tr>
<tr><td colspan="8">Topics: Convolutional Networks- Architecture of CNN -Sequence Modeling: Recurrent and Recursive Nets – Feature Selection – Max Pooling – Filters and Feature Maps – Convolution Layer – Training and optimization of CNN parameters -Applications-</td></tr>
<tr><td>Module 3</td><td colspan="2">Deep Learning</td><td>Quiz and assignments</td><td></td><td colspan="2">10 SESSION</td></tr>
<tr><td colspan="8">Topics: Machine Learning Basics-Deep Feedforward Networks- Regularization for Deep Learning- Optimization for Training Deep Models- Recurrent Neural Network – Memory cells – sequence analysis – Reinforcement Learning –Q Learning – Applications: Deep learning for computer vision- Deep Learning Models for Healthcare Applications.</td></tr>
<tr><td colspan="8">Targeted Application & Tools that can be used:
Application Area includes all modern electronic devices (Automation, Communication systems). 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</td></tr>
<tr><td colspan="8">Project work/Assignment:</td></tr>
</table>

1.Case Studies: At the end of the course students will be given a real-world scenario for any application like Quality Test Project, Music Genre Classification Machine Learning Project, Handwritten Character Recognition. 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.Deep Neural Network for Image Classification-Build and apply a deep neural network to supervised learning
2.**Realize a Perceptron network for an AND function with bipolar inputs and targets.**
To perform the above task using matlab or Python. Improvise the same to increase the number of inputs for the same implement.
3. How to classify images using the following Convolutional Neural Networks models pre-trained on the ImageNet dataset with Python and the Keras deep learning library AlexNet ,VGGNet ,ResNet Inception, perform the task using matlab or Python. Improvise the same by changing the images to consider and specific domain like medical or terrain images and observe the changes in classification.

Text Book(s):

3. Simon S. Haykin, Neural Networks and Learning Machines, 3rd Ed, Pearson, 2009.
4. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing NextGeneration Machine Intelligence Algorithms", O'ReillyMedia, 2017.

References:

Reference Book

1. José C. Principe, Neil R. Euliano, W. Curt Lefebvre, Neural and Adaptive Systems: Fundamentals through Simulations, John Wiley and Sons, 2000.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
3. K. Mehrotra, C. Mohan, and S. Ranka, "*Elements of Artificial Neural Networks"*, MIT Press

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

Introduction to Neural Networks | Engineering Education (EngEd) Program | Section
Introduction to the Artificial Neural Networks (semanticscholar.org)
Introduction to Neural Networks Basics (dataaspirant.com)
Microsoft PowerPoint - 1 - Intro.ppt (stir.ac.uk)
Index of /~tba3/stat665/lectures (yale.edu)
Introduction to Neural Network| Convolutional Neural Network (analyticsvidhya.com)
Course Notes: Idempotent Productions (stanford.edu)
NPTEL - https://nptel.ac.in/courses/117/105/117105084/
Artificial neural networks: a tutorial **https://ieeexplore.ieee.org/abstract/document/485891**
Artificial neural networks **https://ieeexplore.ieee.org/abstract/document/8118**
Python Machine Learning Tutorial (Data Science) - Bing video
Presidency University Library Link https://presiuniv.knimbus.com/user#/home

E-content:

30. 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
31. 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

32. 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
33. 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 related to development of " **SKILL DEVELOPMENT** ":Single Layer Feed Forward N/W, Multilayer Feed Forward N/W-Applications of ANN- Optimization for Training Deep Models

Catalogue prepared by	Dr G MUTHUPANDI Mrs ANUPAMA SINDGI
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3027	**Course Title:** Industrial Automation and Control **Type of Course:** Discipline Elective Theory Only	**L - P - C**	**3**	**0**	**3**
Version No.	**2.0**				
Course Pre-requisites	**1] Digital Control Systems (ECE3005)** **Concepts of analog to digital and digital to analog conversions. To know about time response specifications of second order systems and Proportional-Integral-Derivative (PID) controllers.**				
Anti-requisites	**Nil**				
Course Description	**The purpose of this course is to enable the students to appreciate the need for Industrial Automation and control which play a key role in modern industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn the basics of automation and working of systems. The course will be supported by various simulation assignments, which will enhance the student's abilities to become a good Industrial Automation and Control engineer.**				
Course Objective	**The objective of the course is to develop EMPLOYABILITY SKILLS of the student by LEARNING ADVANCE techniques.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** **1) Discuss various components and parameters used in industrial automation.** **2) Demonstrate the working principles of PLCs.** **3) Illustrate the concepts of Distributed Control System (DCS).** **4) To provide a good understanding of Internet of Things (IoT) and its envisioned deployment domains.**				
Course Content:					
Module 1	**Introduction to Industrial Automation**	**Assignment / Quizzes**	**Data Collection and Analysis**	**14 Classes**	
Topics: **Automation components: Need for process control, Pressure to Current (P/I), current to pressure (I/P) converters, basic Control elements, open loop and closed loop control systems. Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT.** **Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and SCADA, Different Systems in SCADA like Field Instrumentation, Remote terminal unit (RTU), Master Terminal Unit (MTU).**					
Module 2	**Programmable logic controllers and Relay Ladder Logic**	**Assignment / Quizzes**	**Programming and Simulation task**	**11 Sessions**	
Topics: **Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries. Relay Ladder Logic and Programming.**					
Module 3	**Distributed Control System**	**Assignment**	**Programming and Simulation task**	**06 Sessions**	

Topics:
Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

Module 4	**Industrial Internet of Things**	**Assignment**	**System Design Task and Analysis**	**08 Sessions**

Topics:
Introduction to Internet of Things - Overview of Internet of Things- the Edge, Cloud and the Application Development, Anatomy of the Thing, Industrial Internet of Things (IIoT – Industry 4.0), Quality Assurance, Predictive Maintenance, Real Time Diagnostics, Design and Development for IoT, Understanding System Design for IoT, Design Model for IoT.

Targeted Application & Tools that can be used

Application Area:
Industrial automation is the technological enhancement of systems and machinery used for industries like manufacturing and production. The goal is to limit procedures performed by human workers. Industrial automation technology helps businesses enhance safety, save time, boost quality production, reduce monitoring, and lower costs. All of these benefits lead companies to higher productivity, greater efficiency, and more profitability.

Professionally Used Software: MATLAB/ SIMULINK, SIMATIC STEP 7-TIA Portal, CODESYS, LabVIEW etc.

Project work/Assignment:

1) **Project Assignment: Work to Design a Humanoid Robot.**
2) **Assignment 1: Collect the data by Simulating analog and digital function blocks.**
3) **Assignment 2: Develop a Logic for implementation of Bottle Filling Application.**
4) **Assignment 3: Develop a Logic for implementation of PID Control Using PLC.**
5) **Assignment 3: Develop a Logic for implementation of 3-axis positioner Using PLC.**

Text Book(s):

1. **Industrial Instrumentation and Control by S.K. Singh The McGraw Hill Companies.**
2. **Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2013.**
3. **The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, Lucas. Darnell, 2016. Jaico Publishing House, 2013.**

References

1) **Programmable logic controller, Dunning, Delmar.**
2) **Process Control Instrumentation Technology by. C.D. Johnson, PHI**
3) **Industrial control handbook, Parr, Newnem.**
4) **D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw Hill Publishing Company Ltd., 1996.**
5) **Joe Biron& Jonathan Follett, Foundational Elements of an IoT Solution – The Edge, The Cloud and Application Development, Oreilly,1st Edition, 2016.**

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

1. NPTEL :: Electrical Engineering - Industrial Automation and Control
2. What is a PLC? PLC Basics Pt1 - Bing video
3. What is DCS? (Distributed Control System) - Bing video

4. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
5. https://presiuniv.knimbus.com/user#/home

E-content:

1. Haijian Wang; Xinyue Liang; Menggao He; Xuefeng Li; Shuyuan Fu Analysis of Application of PLC Technology in Automation Control of Electrical Engineering. 2020 IEEE Conference on Telecommunications, Optics and Computer Science (TOCS) https://ieeexplore.ieee.org/document/9339623
2. Michel de Mattos Fernandes; Jeferson André Bigheti; Ricardo Pasquati Pontarolli; Eduardo Paciencia Industrial Automation as a Service: A New Application to Industry 4.0. IEEE Latin America Transactions (Volume: 19, Issue: 12, December 2021) https://ieeexplore.ieee.org/document/9480146
3. Y. L. Cai, Q. He, J. Duan and Z. Y. Gao, "Full-order observer-based output regulation for linear heterogeneous multi-agent systems under switching topology", *Journal of Artificial Intelligence and Systems*, vol. 1, pp. 20-42, 2019. https://iecscience.org/jpapers/20
4. Zhao Zining, Fu Yongling and Chen Luxi, "System design of linear position tracking experimental device based on PLC", *Machine Tool and Hydraulics*, vol. 45, no. 13, pp. 99-104, 2017. https://www.researchgate.net/publication/337447159_Design_and_Implementation_of_PLC-Based_Monitoring_and_Sequence_Controller_System
5. G.Madhan, G. R. Kandhasamy and S. Muruganand, "Design and Implementation of PLC based Computerized Monitoring in Dip Coating System", International Journal of Computer Applications, Vol. 57, No 16, 2012. https://www.ijcaonline.org/archives/volume57/number16/9197-3720.
6. Bruno Cunha INESC TEC, Porto, Portugal and Cristóvão Sousa CIICESI-ESTG, Politécnico do Porto, Felgueiras, Portugal, "On the Definition of Intelligible IIoT Architectures" https://ieeexplore.ieee.org/document/9476342.

Topics relevant to development of "EMPLOYABILITY SKILLS": Modelling of PLC using Ladder diagram &, Sequential flow chart. Building a PLC system using programming.

Topics relevant to development of "ENVIRONMENT AND SUSTAINABILITY": Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement and Actuators, process control.

Topics relevant to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Different Systems in SCADA like Field Instrumentation, RTU and MTU & DCS.

Catalogue prepared by	Mr. Syed Abrar Ahmed Mr. Tony Aby Varkey M
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Signal Processing Basket

<table>
<tr><td>Course Code:
ECE 3028</td><td colspan="4">Course Title: Speech Signal Processing

Type of Course: Discipline Elective in Signal processing basket Theory & Integrated Laboratory.</td><td>L- P- C</td><td>3</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">[1] Digital Signal Processing [ECE3005]

Basic concepts like Energy, Magnitude, Zero Crossing rate, Autocorrelation function, pole zero analysis, DFT and some basic mathematical concepts.</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 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.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">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.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals of Human Speech Production</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes and assignments/simulation task</td><td colspan="2">10 Sessions</td></tr>
<tr><td colspan="9">Topics:
Introduction to Speech, The Mechanism of speech production, Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates</td></tr>
<tr><td>Module 2</td><td colspan="2">Discrete time speech signals</td><td>Assignment</td><td colspan="3">Comprehension based Quizzes and assignments; simulation with MATLAB</td><td colspan="2">10 Sessions</td></tr>
<tr><td colspan="9">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</td></tr>
</table>

Module 3	**Frequency domain methods for speech processing**	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB	**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.**				
Project work/Assignment/Quiz: **1. Project Work: For each of the two vectors, VoicedSig and UnvoicedSig, list the average energy and number of zero-crossings. Which segment has a greater average energy? Which segment has a greater zero-crossing rate?** **2. Case Studies:** Speech signal processing is just like as the speech processing in which first the signal is studied and then being processed in the form of digital processing. It involves the signals like audio signals, image signals, electrocardiogram signals and control system signals. The speech signal processing is the combination of the speech processing and the signal processing. Speech processing is just the study of the signals like audio, image, etc. and then these signals are being processed in the form of digital representation. Develop suitable algorithm and methods to process speech signal **3. Assignments:** Students will be given different assignments from time to time to understand their learning. Sample assignments are mentioned below: **Assignment 1:** There are variety of ways classifying speech sounds into distinctive sounds i.e phonemes. These methods fall under the study of articulatory phonetics and acoustic phonetics. What is the difference between the voiced fricatives /z/, as in “azure “and the unvoiced fricative /S/, as in “she”. **Assignment 2:** A vowel is a syllabic speech sound pronounced without any stricture in the vocal tract. Vowels are one of the two principal classes of speech sounds, the other being the consonant. The following characters define a vowel sound **Assignment3:** Suppose you have a signal whose duration is 5ns, Short time energy is useful in detecting voiced segments of speech. It is also useful to detect unvoiced segments. Short time Energy and Short time Magnitude is used to classify speech in to Voice from silence and Background noise. If the Energy and Magnitude of the signal is high then the speech segment could be				

Assignment 4:
Zero crossing rate is a measure of frequency content of the signal. Assume the sampling rate of sinusoidal signal Fs is 20000 Hz , and Fo=200 Hz, what is mean zero crossing rate

4. 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. **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
5. **Fundamentals of Speech Recognition https://books.google.co.in/books/about/Fundamentals_of_Speech_Recognition.html?id=XEVqQgAACAAJ&redir_esc=y**
6. **Deep Learning for NLP and Speech Recognition https://link.springer.com/book/10.1007/978-3-030-14596-5**
7. **ASRoIL: a comprehensive survey for automatic speech recognition of Indian languages https://link.springer.com/article/10.1007/s10462-019-09775-8**
8. **Government projects on ASR (CDAC) https://www.cdac.in/index.aspx?id=mc_st_Speech_Recognition**

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 development of “FOUNDATION SKILLS”: Phonetics, Time dependent processing of speech signal. Topics relevant to development of “EMPLOYABILITY”: 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 Topics relevant to development of “HUMAN VALUES & PROFESSIONAL ETHICS”: Mechanism of Speech Production, Voice Response System.	
Catalogue prepared by	Ms. Aruna M Ms. Anupama Sindgi Mr. Arvind Kumar
Recommended by the Board of Studies on	BOS NO: 12 th. BOS held on 23/4/21
Date of Approval by the Academic Council	Academic Council Meeting No. 14, Dated 21/5/21

Course Code: **ECE3029**	**Course Title:** **Digital Image Processing** **Type of Course:** **Discipline Elective in Signal Processing Basket – Theory and Integrated lab**	**L-P-C**	3	2	4
Version No.	1.0				
Course Pre-requisites	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.				
Anti-requisites	**NIL**				
Course Description	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. The lab sessions and Programming assignments provides an opportunity to validate the concepts taught as well as enhances the ability to visualize the real-world problems in order to provide a solution using various MATLAB simulation with required tool boxes.				
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. **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. 5. **Apply** arithmetic and logical operation on real time image using MATLAB tool 6. **Verify** various geometrical transformations on images using MATLAB tool.				
Course Content:					
Module 1	**Fundamentals Of Image Processing**	Application Assignment	Data Analysis task	**10session**	
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.					
Module 2	**Image Enhancement**	Assignment	Simulation and data analysis task	**12 session**	
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				
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.

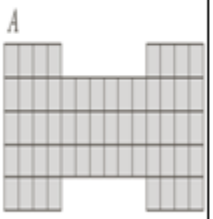
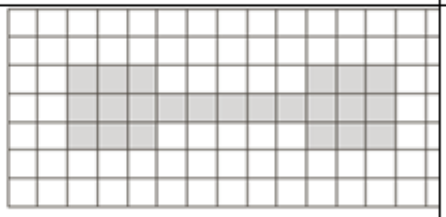
A

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

Project work/Assignment:

Project Work: Day by day the traffic issue has become a major problem in India due to the rising number of motor vehicles. For this reason, one has to utilize the traffic signals which can do the real-time checking of compactness of traffic. This project employs an arrangement of image processing for controlling the traffic in an easy way by capturing images of traffic at crossroads. A step-by-step procedure for changing the duration of the traffic light depends on the traffic density of crossroads at a traffic signal.

Case Study: Digital Image Processing is much in demand especially in medical fields due to which the experts are able to detect even a very small flaw in working of the body parts, Diagnosing the kidney stone in human is one such application of Digital image Processing. Perform the Data collection of Ultra sonic scan reports on kidney stones from Diagnostic Centre's in Bangalore. Prepare a report by identify various parameter which will be analyzed for data processing.

Assignment 1: Digital Image Processing helps in finding out very minute details of any structure which is fed .Some applications require the comparison between the size of body parts periodically so that any abnormalities or deviation from the standard size is tracked timely to save the life of the patient. Prepare a compressive report on the patient age and size of Kidney from the scan reports.

Assignment 2: Histogram Equalization is an image processing technique that adjusts the contrast of an image by using its histogram. To enhance the image's contrast, it spreads out the most frequent pixel intensity values or stretches out the intensity range of the image. By accomplishing this, histogram equalization allows the image's areas with lower contrast to gain a higher contrast.Implement the histogram equalization to the given input images , submit your code and the output images.

Assignment 3: A professor of archeology doing research on currency exchange practices during the Roman Empire recently became aware that four Roman coins crucial to his research are listed in the holdings of the British Museum in London. Unfortunately, he was told after arriving there that the coins recently had been stolen. Further research on his part revealed that the museum keeps photographs every item for which it is responsible. Unfortunately, the photos of the coins in question are blurred and degraded. Interpret the technique professor can use to restore and enhance the subject of interest.

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.

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 related to development of "FOUNDATION": Steps in image processing systems –Image Sensing and acquisition – Image formation model.

Topics related to development of "EMPLOYABILITY": Representation of Digital Images,Image operation, Image segmentation, Image Analysis, Color And Morphological Image Processing.

Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETICS": Ethical practices to

be observed while doing Image processing .	
Catalogue prepared by	Dr K BhanuRekha, Annapurna.H.S
Recommended by the Board of Studies on	15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: **ECE 3030**	**Course Title: Fuzzy Logic and its Engineering Applications** **Type of Course: Discipline Elective in Signal processing basket Theory**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**[1] Familiar with Secondary school Mathematics and Engineering Mathematics** **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	**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:** 5) **Explain** the concept of fuzzy logic and fuzzy system theory. 6)**Discuss** the application of fuzzy system theory in artificial intelligence. 7)**Understand** various issues in fuzzy system theory. 8) **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

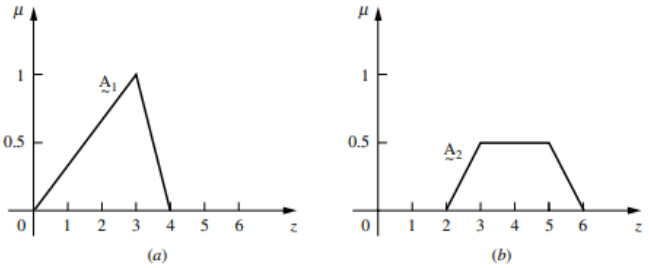
Project work/Assignment/Quiz:

1. Assignment 1:
Develop a reasonable membership function for the following fuzzy sets based on height measured in centimeters: (a) "Tall" (b) "Short" (c) "Not short"

2. Assignment 2:
The question of whether a glass of water is half-full or half-empty is an age-old philosophical issue. Such descriptions of the volume of liquid in a glass depend on the state of mind of the person asked the question. Develop membership functions for the fuzzy sets "half-full," "full," "empty," and "half-empty" using percent volume as the element of information. Assume the maximum volume of water in the glass is V0. Discuss whether the terms "half-full" and "half-empty" should have identical membership functions. Does your answer solve this ageless riddle?

3. Assignment3:
Industry A discharges wastewater into a nearby river. Wastewater contains high biological oxygen demand (BOD) and other inorganic contaminants. The discharge rate of rivers and wastewater is constant through the year. From research, it has been found that BOD values not exceeding 250 mg/L do not cause any harmful effect to aquatic ecosystems. However, BOD values higher than 250 mg/L have significant impact. Draw both a crisp and fuzzy membership function to show the effects of the BOD value on aquatic ecosystems.

4. Assignment 4:
In metallurgy materials are made with mixtures of various metals and other elements to achieve certain desirable properties. In a particular preparation of steel, three elements, namely iron, manganese, and carbon, are mixed in two different proportions. The samples obtained from these two different proportions are placed on a normalized scale, as shown in Figure and are represented as fuzzy sets A1 and A2. You are interested in finding some sort of "average" steel proportion. For the logical union of the membership functions shown we want to find the defuzzified quantity. For each of the seven methods presented in this chapter assess (a) whether each is applicable and, if so, (b) calculate the defuzzified value, $z*$.



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):

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 development of "SKILL": Fuzzy Set Operations, Fuzzification and De-fuzzification.
Topics relevant to development of "EMPLOYABILITY": Fuzzy Classification and Pattern Recognition
Topics relevant to development of "ENVIRONMENT AND SUSTAINABILITY SKILLS": Genetic Algorithms, Inductive Reasoning, Machine learning using Fuzzy Logic

Catalogue prepared by	Dr. Arvind Kumar
Recommended by the Board of Studies on	BOS NO: 12th. BOS held on 10/08/21
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 03/08/22

Course Code: ECE3031	**Course Title: Applications of Deep Learning** **Type of Course: Discipline Elective, General Basket** **Theory only**		**L-P-C**	3 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	**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 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

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):

9. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 1st Edition

Reference(s):

Reference Book(s):

7. James Loy "Explore neural networks with Python", Packt Publisher,1st Edition
8. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 1st Edition
9. Seth Weidman "Deep Learning from Scratch ", O'Reilly Media, 1st Edition
10. Francois Chollet "Deep Learning with Python", Manning Publications, 2nd Edition.

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

16. Free online self-paced course :- https://open.cs.uwaterloo.ca/python-from-scratch/
17. Online notes :- https://open.cs.uwaterloo.ca/language-independent-lessons/
18. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106106201/L01.html
19. Online ppts :- https://cs.uwaterloo.ca/~mli/Deep-Learning-2017-Lecture5CNN.ppt
20. Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt
21. https://presiuniv.knimbus.com/user#/home

E-content:

34. 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
35. 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
36. 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
37. 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 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	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	BOS Meeting NO: 12th, held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3032	**Course Title:** **Multimedia Signal Processing** **Type of Course:** **Discipline Elective from Signal Processing Basket & Theory only**	**L- P- C**	3	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 skill development of student by using Participative Learning techniques				
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 Multimedia	Assignment	Programming Task, Data Analysis task	**12 classes**

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

Project work/Assignment:

Project Assignment: A computer type project to enhance the understanding of the topics covered in the class or to investigate a related topic not covered in the class. A final report and presentation are required.
Assignment 1: Programming based Programming based numerical assignment on model based coding

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 development of "Foundation Skills": Digital Processing Basics for Multimedia Processing and Communications; Audio and Video Compression Basics

Topics relevant to development of "Employability": Audio and video compression Standards

Topics relevant to development of "Human values and Professional Ethics": Ethical practices to be observed while using multimedia techniques.

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3033**	**Course Title: Adaptive Signal Processing** **Type of Course: Discipline Elective / Signal Processing Basket and Theory Only**		**L- P- C**	3	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 SKILL DEVELOPMENT 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 Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques.**				
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 **EMD and ITD",** IEEE Access Vol 7,2019 **DOI:** 10.1109/ACCESS.2019.2956077				
Topics relevant to development of "FOUNDATION SKILLS": WIENER FILTERS: Linear optimum filtering problem statement.				
Catalogue prepared by	Dr Dharmesh Kumar Srivastava			
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021			
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/22			

Course Code: ECE3034	**Course Title:** Bio-Instrumentation Systems **Type of Course:** Discipline Elective - Signal Processing Basket	**L- P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**[1] Linear Integrated Circuits, 2] Measuring Instruments and Sensors** **Basics of Operational Amplifiers, Design of Instrumentation Amplifiers, Filters, oscillators. Transducers and sensors principles, classification of transducer.**				
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	**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) 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.					
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,

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.

Project work/Assignment:

Project Assignment: Carry out a survey on instruments used in medical field for diagnosis, treatment and prevention of diseases

Assignment: 1] Give insight into the modern imaging system.

Assignment 2: A short report on optical fiber sensor with its recent advancements in Biomedical.

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.

Catalogue prepared by	Dr. Ajit Kumar
Recommended by the Board of	10th BOS held on 17/01/2020

Studies on	
Date of Approval by the Academic Council	Meeting No. 16th, Dated 23/10/2021

<table>
<tr><td>Course Code:
ECE3035</td><td colspan="4">Course Title: Biomedical Signal Processing

Type of Course: Discipline Elective Theory only</td><td>L- P- C</td><td>3</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 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.</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">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.</td></tr>
<tr><td>Course Objective</td><td colspan="9">This course is designed to improve the learners' <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> methodologies by analyzing various Bio- signals.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">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.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="2">Biosignals and its Origin</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">12 Classes</td></tr>
<tr><td colspan="10">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Noise Removal and Processing of Biosignals</td><td>Assignment / Quiz</td><td colspan="3">Programming and Simulation task</td><td colspan="2">12 Classes</td></tr>
<tr><td colspan="10">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</td></tr>
<tr><td>Module 3</td><td colspan="2">Analysis of Biosignals</td><td>Assignment</td><td colspan="3">Memory Interfacing Task and Analysis</td><td colspan="2">15 Classes</td></tr>
</table>

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),
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

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.

Project work/Assignment:

1. **Case Studies:**
   The development of techniques to analyze biomedical signals, such as electro-cardiograms, has dramatically affected countless lives by making possible improved noninvasive diagnosis, online monitoring of critically ill patients, and rehabilitation and sensory aids for the handicapped. Rangaraj Rangayyan supplies a practical, hands-on field guide to this constantly evolving technology in Biomedical Signal Analysis, focusing on the diagnostic challenges that medical professionals continue to face. Dr. Rangayyan applies a problem-solving approach to his study.
   https://ieeexplore.ieee.org/book/5264168
2. **Project Assignment:** Carry out a signal analysis task for a biomedical signal database consisting of ECE / EEG / EMG or other types of signals.
3. **Assignments:**
   Assignment1: Collect the Biosignal data (ECG / EEG / any other signal) for identifying a typical health condition and perform the necessary processing and apply various algorithms to detect the intended health condition.
   Assignment 2: Prepare a comprehensive report on various biosignals necessary for vital sign monitoring and the research as well as commercial prototypes that exist in public domain.
4. **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.

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.

3.

Reference(s):

4. Devasahayam S. R., “Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling”, Kluwer Academic/Plenum Publishers, 5th edition, New York, 2000.
5. Reddy D. C., “Biomedical Signal Processing: Principles and Techniques”, Tata McGraw-Hill Publishing Co. Ltd, 2005.
6. 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.):

22. 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/
23. Prof. Sudipta Mukhopadhyay NPTEL Lecture Notes and Videos: https://nptel.ac.in/courses/108105101
24. Fatemeh Hadaeghi Lecture Notes (from Jacobs University Bremen): https://www.ai.rug.nl/minds/teaching/courses/t2018biomed/
25. Dr. Kunal Pal’s Video lectures on “Biomedical Signal Processing” from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8
26. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

38. 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
39. 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
40. 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
41. 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
42. 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 related to development of “FOUNDATION”: Signals such as ECG, EEG, EMG, EOG
Topics relevant to development of “EMPLOYABILITY”: Analysis of ECG / EMG / EEG signals
Topics relevant to “GENDER SENISITASATION”: Practices followed for data collection from opposite gender patients.

Catalogue prepared by	Ms. Natya.S
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3036	**Course Title:** **Probabilistic Systems analysis** **Type of Course:** **Discipline Elective from Signal Processing Basket** **Theory only**	**L- P-C**	3	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) **Djscuss** the basics of probability, sample space, events, statistics and apply them to real life problems (Comprehension) 2) **Distinguish** probability density and distribution functions for single and multiple random variables and calculate the statistical parameters for random variables (Comprehension) 3) **Apply** the concept of random processes along with its parameters in estimating the correlation, covariance and PSD. (Application)				
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.

Topics relevant to development of "Employability": Markov chains; Central limit theorem, Bayesian statistical inference.

Catalogue prepared by	Dr. Sumantra Chaudhuri
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3037	**Course Title:** Audio Signal Processing for Music Applications **Type of Course:** Discipline Elective, General Basket Theory only		**L- P- C**	3	0	3
Version No.	2.0					
Course Pre-requisites	**Basic signal processing operations, analysis and representation of signals**					
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 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.**					
Course Objective	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by EXPERIMENTAL LEARNING using the signal processing toolbox/Matlab.**					
Course Outcomes	**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.**					
Course Content:						
Module 1	Introduction to discrete signal processing	Assignment	Programming Task		**10 Classes**	
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**.**						
Module 2	Sinusoidal coders	Assignment	Programming Task		**10 Classes**	
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.						
Module 3	Musical signal analysis	Project Assignment	Programming Task		**10 Classes**	
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.						

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Music industry, Design and development of musical instruments, Audio signal processing research areas

Professionally Used Software: Python open software, matlab /simulink

Project work/Assignment:

1.Project Assignment: Implement any simple music retrieval process using Python. [like cover song detection, background music etc.]

2. Assignment : Generating sinusoids and implementing DFT in Python or Matlab.

3. 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 .**

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 Foundation Skills: Various Fourier Transforms, Digital filters, Multirate signal processing, Sinusoidal signal analysis.

Topics relevant to Employability: Music analysis and synthesis, Acoustic modelling using digital waveguide.

Catalogue prepared by	Mrs. Amrutha V Nair
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3038	**Course Title: Electronic Music Production** **Type of Course: Discipline Elective in Signal processing basket Theory**	**L- P- C**	3	0	3
Version No.	1.0				
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 <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:** 9) **Explain** the concept of signal processing and music theory. 10) **Discuss** and design different algorithms of music production. 11) **Understand** various issues in music production. 12) **Illustrate** the application of electronic music production through compositions.				
Course Content:					
Module 1	**The Technology of Music Production**	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**	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, Building bass lines and harmonic accompaniment, Live looping of different elements for live audience.

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

Project work/Assignment/Quiz:

1. Case Studies: 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: Record two audio signals and mix them using mixing tools.
Assignment 2: Create a music to express happy emotion.

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):

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.

<table>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">Topics relevant to development of “SKILL”: Music signal processing.
Topics relevant to development of “EMPLOYABILITY : Music synthesis, creating sounds
Topics relevant to development of “ENVIRONMENT AND SUSTAINABILITY SKILLS”: Team work, analyzing natural sounds, composition of new sounds</td></tr>
<tr><td>Catalogue prepared by</td><td>Mr. Arvind Kumar</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS NO: 12 th. BOS held on 07/08/21</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 16, Dated 23/10/21</td></tr>
</table>

Course Code: ECE3039	**Course Title: DSP Processors** **Type of Course: Discipline Elective Theory**	**L-P-C**	3	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 SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 6. Understand the basics of Digital Signal Processing and transforms. 7. Able to distinguish between the architectural features of General purpose processors and DSP processors. 8. Understand the architectures of TMS320C54xx devices and Acquire knowledge about various addressing modes 9. 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**	Assignment	Analysis and Verification	**10 session**	

	Algorithms			
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.				
Project Work/Assignment:				
1.Case Studies: At the end of the course students will be given a 'real-world' application of a DSP processor for audio processing as a case study. Students will be submitting a report which will include Progran, 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:** Leading manufacturers of integrated circuits such as Texas Instruments (TI), Analog devices & Motorola manufacture the digital signal processor (DSP) chips. These manufacturers have developed a range of DSP chips with varied complexity. The TMS320 family consists of two types of single chips DSPs: 16-bit fixed point &32-bit floating point. In this DSP project, we will implement various DSP Algorithm such as 8 point FFT, IIR Filters etc., on Digital Signal Processor boards and observe the output variations. **Assignment 1:** Implement FFT Algorithm using any Digital Signal Processor **Assignment 2:** If a sum of 256 products is to be computed using a pipelined MAC unit, and if the MAC execution time of the unit is 100nsec, what will be the total time required to complete the operation?				
Text Book(s): **10.** Avtar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004 11. .B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications‖, Tata				
Reference(s): **Reference Book(s):** 11. Jonatham Stein, Digital Signal Processing‖, John Wiley, 1st Edition, 2000. 2. Sen M. Kuo & WoonSergGan, 12. Digital Signal Processors Architectures, Implementation and Application‖, Pearson Practice Hall, 1st Edition, 2013				

13. Digital Signal Processing –Principles, Algorithms Applications by J.G. Proakis & D.G. Manolokis, PHI, 2005

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

27. 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:

43. Gustavo Ruiz, Juan A. Michell, Design and Architectures for Digital Signal Processing. 2013, https://www.intechopen.com/books/3158
44. "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 related to development of “FOUNDATION”: The Sampling Process.
Topics related to development of “EMPLOYABILITY”: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs.
Topics related to development of “Entrepreneurship”: Interfacing Memory and I/O Peripherals, Memory space organization
Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: Pipelining and Performance.
Topics related to development of “HUMAN VALUES AND PROFESSIONAL ETHICS”: Application of DSP Processors

Catalogue prepared by	Mrs. KEHKESHAN JALALL S
Recommended by the Board of Studies on	BOS NO: 12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 03/08/2022

VLSI and Embedded Systems Basket

<table>
<tr><td>Course Code:
ECE3040</td><td colspan="3">Course Title: Embedded Systems
Type of Course: Discipline Elective Theory only</td><td>L-P-C</td><td>3</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">Comparison between microprocessors and microcontrollers, Instruction set of microprocessors and microcontrollers, Real world interfacing, Embedded C programming.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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).</td></tr>
<tr><td>Course Objective</td><td colspan="7">This course is designed to improve the learner’s <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals of Embedded Systems</td><td>Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">9 sessions</td></tr>
<tr><td colspan="8">Topics:
What is an Embedded System?, Inside the Embedded System, Embedded Processors, Memory Systems, Basic Peripherals, Interfacing to the Analogue world, Interrupts and Exceptions</td></tr>
<tr><td>Module 2</td><td colspan="2">ARM Architecture</td><td>Quiz, Mid Term Exam</td><td colspan="2">Memory Recall based Quizzes, Mid Term Exam</td><td colspan="2">12 sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 3</td><td colspan="2">ARM Programming and Interfacing</td><td>Assignment</td><td colspan="2">Programming Assignment</td><td colspan="2">12 sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 4</td><td colspan="2">Real Time Operating Systems (RTOS)</td><td>End Term Exam</td><td colspan="2">End Term Exam</td><td colspan="2">12 sessions</td></tr>
<tr><td colspan="8">Topics:
Introduction to Embedded Real Time Operating Systems (RTOS), Types of RTOS, Architecture of</td></tr>
</table>

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):

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

Reference(s):
Reference Book(s):

5. Jonathan W. Valvano, "Embedded Systems: Introduction to Arm® Cortex™-M Microcontroller- Vol 01", CreateSpace Independent Publishing Platform, 1st Edition
6. Jonathan W. Valvano, "Embedded Systems: Real-Time Operating Systems for Arm® Cortex™-M Microcontrollers", CreateSpace Independent Publishing Platform, 1st Edition.
7. ARM Cortex Datasheet available on (https://www.arm.com/)
8. 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.):

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

E-content:

45. Joseph Sifakis, " Embedded systems design - Scientific challenges and work directions 2009 Design, Automation & Test in Europe Conference & Exhibition https://ieeexplore.ieee.org/document/5090623
46. Gabor Karsai; Fabio Massacci; Leon Osterweil; Ina Schieferdecker," Evolving Embedded Systems", Computer , VOL. 43, issue.5 https://ieeexplore.ieee.org/document/5472888
47. Sachin P. Kamat," An eye on design: Effective embedded system software", IEEE Potentials, VOL. 29, issue.5

https://ieeexplore.ieee.org/document/5568178
48. 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	Mr. Mohammed Mujahid Ulla Faiz
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3041	**Course Title: REAL TIME SYSTEMS** **Type of Course: Discipline Elective** **VLSI and Embedded Systems Basket** **Theory Only**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Microcontroller Applications ,Proficiency with ANSI-C and C++ is required. Familiarity with Microcontroller-Based systems along with relevant open source tools.**				
Anti-requisites	**NIL**				
Course Description	**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.**				
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) 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.				
Course Content:					
Module 1	**Introduction to Real-Time Systems & Concepts of Computer Control**	Assignment/Quiz Memory Recall based Quizzes	**06 classes**		
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.					
Module 2	**Languages for Real-Time Applications**	Assignment / Quiz Programming task	**10 classes**		
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.					
Module 3	**Operating Systems Concepts**	Assignment/Quiz System Design Task and Analysis	**10 classes**		
Topics: 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, Auto motives.** **Professionally Used Software: CODE COMPOSER STUDIO, MATLAB**			
1. 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 .** **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 Real time systems using Python/ 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			
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 related to development of "FOUNDATION": Design of Real time computing systems,Manufacturing and security engineering.
Topics related to development of "EMPLOYABILITY": Foreground/Background System, Real-time Support, Compilation of Modular Programs, Task Management, Task Co-Operation and Communication
Topics related to development of "ENTREPRENEURSHIP":
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Task Management, Scheduler and Real-Time Clock Interrupt Handler, Task Co-Operation and Communication
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS":
Topics relevant to development of "FOUNDATION SKILLS":Design of Real time computing systems,Manufacturing and security engineering.

Catalogue prepared by	Mrs.ANNAPURNA.H.S
Recommended by the Board of Studies on	BOS NO: 12 th BOS held on 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3042**	**Course Title: MEMS and Nanotechnology** **Type of Course: Discipline Elective Theory**		**L- P- C**	3 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 <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:** i) Discuss Methods for Processing MEMS materials ii) Develop Characteristic techniques of micro system fabrication process iii) Demonstrate the concepts of Nano technology iv) Illustrate nano materials and various nano measurements techniques v) Implement nano scale manufacturing				
Course Content:					
Module 1	**Introduction and Fundamentals MEMS Device Physics**	Assignment/ Quiz	Memory Recall based 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, 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/ Quiz	Memory Recall based 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/ Quiz	Memory Recall based 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/ Quiz	Memory Recall based Quizzes	**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.**

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 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):

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 related to development of "FOUNDATION SKILLS":
The student will learn about the basics of amplification and oscillators from the foundation skills

Topics related to development of "SKILL":
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.

Topics related to development of "EMPLOYABILITY":
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 Tuneable capacitors.

Catalogue prepared by	Dr. Puneeth S B Dr. Pritam Keshari Sahoo Dr. Ashutosh Anand
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3043	**Course Title: Mixed Signal Circuit Design** **Type of Course: VLSI and Embedded Systems Basket Theory Only**	**L- P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Basic Concepts of Operational Amplifiers, the parameters of Op-Amps, open loop and closed loop configurations of Op-Amps, inverting and non-inverting Operational Amplifier and Applications of Op-Amp. Modelling and operation of MOSFET, biasing of MOSFET.**				
Anti-requisites	**NIL**				
Course Description	The purpose of the course is to provide the exposure to students about the mixed signal circuits by integrating various analog and digital circuits. The course helps students to learn how to design and implement product level design blocks for various VLSI applications. The course is designed with considering the need of VLSI design industry. This course encourages students to choose career as Analog or Mixed circuit design Engineer.				
Course Objective	This course is designed to improve the learner's Employability skills by learning about the architecture of basic building blocks which are used in mixed signal IC design.				
Course Outcomes	**On successful completion of this course the students shall be able to:** **1) Understand** the concepts of MOS Operational Amplifiers. **2) Describe** the concepts of Switched Capacitor Circuits and realize the concepts of PLL. **3) Memorize** the modeling and architecture of data converters and Oversampling Converters. 4) **Relate** the concepts of Phase Locked Loop and Voltage Controlled Oscillator.				
Course Content:					
Module 1	**Operational amplifiers and Comparators**	Assignment / Quiz	Memory recall based Quiz	**14 Sessions**	
Topics: **Operational amplifiers:** Basic two stage MOS Operational amplifier–Characteristic parameters, two stage MOS Op-Amp with Cascode. MOS Folded Cascode Op-amp. Fully differential folded Cascode op-amp. Current feedback op-amps. Stability and frequency compensation of op-amps. Phase margin and noise in op-amps. **Comparators:** Op-Amp Based Comparators, Charge Injection Errors – Latched Comparators – CMOS and BiCMOS Comparators.					
Module 2	**Switched capacitor circuits and PLL**	Assignment / Quiz	Implementation using Simulation Tools	**13 Sessions**	
Topics: **Switched capacitor circuits:** Basic building blocks, basic operation and analysis, inverting and non-inverting integrators, signal flow diagrams, first order filter. Sample and hold circuits - Performance requirements, MOS sample and hold basics, clock feed through problems, S/H using transmission gates, high input impedance S/H circuits. **Phase locked loops**: Basic loop architecture. PLLS with charge pump phase comparators – dynamics of PLLS. Voltage controlled oscillators, characteristics of PLLS. Applications of PLLS.					
Module 3	**Fundamentals and Classification of Convertors**	Assignment / Application	Implementation using Simulation Tools	**12 Sessions**	

Topics:
Data converter fundamentals: Performance characteristics, ideal D/A and A/D converters, quantization noise.
Nyquist rate D/A converters: Decoder based converter, binary-scaled converters. Thermometer code converters.
Nyquist rate A/D Converters: Integrated converters – successive approximation converters, cyclic A/D converters, Flash or parallel converters.
Oversampling Converters: Noise shaping modulators, Decimating filters and Interpolating filters, Higher order modulators.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Application: VLSI Industries for IC Fabrication, Chip Designing, Digital Signal Processing, Digital Image Processing, Telecom Industries / Broadcasting Companies, Mobile Manufacturing Industry, Medical Applications.

Professionally Used Software: MATLAB / SIMULINK, LAB View, E-Multisim, P-Spice, CADENCE, INTEL Quartus Prime.

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: Analog to Digital Convertor enables high-frequency applications (typically in a few GHz range) like radar detection, wideband radio receivers, electronic test equipment, and optical communication links. More often the flash ADC is embedded in a large IC containing many digital decoding functions. Stud5ents has to design a Flash ADC with different features.

Textbook(s):

T1. Paul.R. Gray & Robert G. Major, Analysis and Design of Analog Integrated Circuits, John Wiley & sons, 5th Edition 2004.

T2. Design of Analog CMOS Integrated Circuits- Behzad Razavi, 2nd Edition.

T3. R. Jacob Baker, “CMOS Mixed-Signal Circuit Design”, Wiley Second Edition.

Reference(s):

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Second Edition.

2. Rudy Van De Plassche, “CMOS Integrated Analog-to- Digital and Digital-To-Analog Converters”, Kluwer Academic Publishers, Second Edition.

3. Richard Schreier, “Understanding Delta-Sigma Data converters”, Wiley Second Edition.

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

1. Video lectures on CMOS Mixed Signal VLSI design by IIT Professors, Bombay https://www.youtube.com/playlist?list=PLLDC70psjvq5vtrb0EdII4xIKA15ec-Ij
2. Video lectures on mixed signal design by Satish Kayshap http://www.satishkashyap.com/2012/08/video-lectures-on-mixed-signal.html
3. Video and e-transcripts on CMOS Analog VLSI design https://nptel.ac.in/courses/117/101/117101105/
4. Video and e-transcripts on CMOS Digital VLSI design https://nptel.ac.in/courses/108/107/108107129/

Presidency University Library Link:

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

E-Content:

1. M. Chanda, S. Jain, S. De and C. K. Sarkar, "Implementation of Subthreshold Adiabatic Logic for Ultralow-Power Application," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. .23, no. 12, pp. 2782-2790, Dec. 2015. https://ieeexplore.ieee.org/document/7018053

2. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in sub-micron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi: 10.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334

3. Gopalaiah, S. V., A. P. Shivaprasad, and Sukanta K. Panigrahi. "Design of low voltage low power CMOS OP-AMPS with rail-to-rail input/output swing." In 17th International Conference on VLSI Design. Proceedings., pp. 57-61. IEEE, 2004. https://ieeexplore.ieee.org/document/1260903.

4. R. Raut and O. Ghasemi, "A power efficient wide band trans-impedance amplifier in sub-micron CMOS integrated circuit technology," 2008 Joint 6th International IEEE Northeast Workshop on Circuits and Systems and TAISA Conference, 2008, pp. 113-116, doi:10.1109/NEWCAS.2008.4606334. https://ieeexplore.ieee.org/document/4606334.

Topics related to development of “FOUNDATION SKILLS”: Applications of MOS Op-Amp.
Topics related to “EMPLOYABILITY”: MOS circuit design which will enhance designing capabilities required for VLSI design hardware industry.
Topics caters to “ENVIRONMENT AND SUSTAINABILITY”: Multi Stage MOS Op-Amps, Integrated Converters.

Catalogue prepared by	Mrs. R Anusha
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3044	**Course Title: IC Fabrication Technology** **Type of Course: Discipline Elective & Theory only**	**L-P-C**	3	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	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques using high end VLSI Design Tools.**				
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

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:- Implementation of various concepts in from deep learning using TCAD and SILVACO

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 development of "Foundation skills": IC Fabrication techniques and procedures.
Topics Relevant to development of "Employability": IC Assembling and Packing.
Topics Relevant to development of "Environment and Sustainability": Crystal growth and lithography

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of	Academic Council Meeting No. 18th, Dated 3/8/2022

Approval by the Academic Council	

Course Code: ECE3045	**Course Title:** Sensor Technology **Type of Course: Discipline Elective:** VLSI and Embedded Systems	**L- P-C**	3	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	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.				
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 related to development of "FOUNDATION": Sensors, Signals, and Systems, Sensor Classification
Topics related to development of "EMPLOYABILITY": Radiometry, Photometry, Light-to-Voltage Converters, Excitation Circuits, Analog-to-Digital Converters,

Catalogue prepared by	Dr. Ashutosh Anand
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3046	**Course Title: Low Power VLSI Design** **Type of Course: Discipline Elective and theory only**	**L- P- C**	3	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	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques using low power techniques in VLSI design in CAD tools.**				
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**	Assignment/Project	Data Analysis	**10 Session**	

	switching, Memory Design			**s**

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.

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:- Implementation of various concepts in from deep learning using TCAD and SILVACO
Project 1. Design a cyclic redundancy Checker using Verilog. Compare the power and area consumption for the code using two different approaches. Design and implement in Xilinx-VIVADO. Also perform debugging using the available tools.

Project 2. Design a low power and highly efficient 8-bit processor using Xilinx Vivado tool and Compare the power consumption with existing codes.

Assignment 1: Design the differential amplifier using GPDK 90nm with the gain of 40dB, gain bandwidth product greater than 5MHz, having a supply voltage of 1.8V, the slew rate is 5V/µs, power dissipation is less than equal to 0.3mW, Positive CMR and negative CMR value is 1.6V and 0.8 V.
Assignment 2: Sketch a transistor-level schematic of a CMOS complex logic gate that realizes (a) the function $F = \overline{(A+B).(C+D)}$ and (b) draw the alternate arrangement of the circuit to minimize the power dissipation.

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 Systemsǁ, 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 related to development of “FOUNDATION SKILLS”: Understand the needs for the low power VLSI design. Factors that affect the power consumption in the design and different optimization techniques to improve the power efficiency.

Topics related to development of “EMPLOYABILITY”: Design of power and signal conditioning circuits and systems for low power electronics devices like energy harvester, accelerometer, gyroscope etc for biomedical, agricultural and industrial application.

Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: Low power systems and efficient power management systems reduces the dependency upon batteries. They can be helpful in the development of efficient low power sensors for remote application that can be used to monitor various environmental calamities or remote applications.

Catalogue prepared by	Ms. Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS Meeting NO: 12th, Dated BOS 10/08/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 3/8/2022

Course Code: ECE3047	**Course Title: CAD for VLSI Type of Course: Discipline Elective, VLSI and Embedded Systems Basket Theory Only**	**L-P-C**	3	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 fundamentals techniques and algorithms used in Computer-Aided Design. This course insight into the modelling, analysis, computer-aided design (CAD) algorithms for real time VLSI applications. The course develops design skills 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. Demonstrate the graph theory algorithms utilized in VLSI Design.** **2. Apply the algorithms of Partitioning, Placement and Floor planning in the VLSI IC design.** **3. Analyse the computational complexity of physical design algorithms.** **4. Illustrate the routing algorithms and its employment in the IC fabrication.**				
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**.**					
Module 3	**Placement, Partitioning and Floorplanning**	Assignment	Design Analysis		**10 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 Synthesis**	Assignment	Programming and simulation		**9 classes**

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.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: 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:

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. 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.

Text Book(s):

1. **S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2006 2nd Edition.**
2. **M. L. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI circuits", 2001 2nd Edition.**

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. Lecture videos for CAD for VLSI Design Part 1 by Prof. V. Kamakoti and Shankar Balachandran Department of Computer Science Engineering, IIT Madras - **https://nptel.ac.in/courses/106/106/106106088/**
2. Power point slides for CAD for VLSI by IIT Kharagpur - **http://www.facweb.iitkgp.ac.in/~isg/CAD/**
3. Lecture video on important CAD tools by Prof. Hitesh Dholakiya by Engineering Funda - **https://www.youtube.com/watch?v=hJTK5nj1iq8**
4. Lecture video on important VLSI CAD Part-1 by Prof. Rob. A. Rutenbar by University of Illinois - **https://www.youtube.com/watch?v=WLdbujc-aH4**
5. Lecture video on important VLSI CAD Part-2 by Prof. Rob. A. Rutenbar by University of Illinois - **https://www.youtube.com/watch?v=zkFRfmySFOw**

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

E-Content:

1. Cong, J. Kahng, A.B. Kwok-Shing Leung " Efficient algorithms for the minimum shortest path Steiner arborescence problem with applications to VLSI physical design" in IEEE transactions on computer Aided Design of Circuits and Systems, Volume: 17, Issue: 1, January 1998, doi:10.1109/43.673630, https://puniversity.informaticsglobal.com:2069/document/673630

2. Dewan, Monzurul Islam; Kim, Dae Hyun “NP-Separate: A New VLSI Design Methodology for Area, Power, and Performance Optimization” in IEEE transactions on computer Aided Design of Circuits andSystems,doi:10.1109/TCAD.2020.2966551. https://puniversity.informaticsglobal.com:2069/document/8957675
3. 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
4. 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.

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	Ms. R Anusha
Recommended by the Board of Studies on	15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3048	**Course Title:** FPGA Design for Embedded Systems **Type of Course:** Discipline Elective & Theory only	**L- P- C**	3	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**	Assignment	Programming assignment	**13 Sessions**	

	Modeling Building FPGA projects			

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

2. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays" Springer-Verlag London Limited, 2009
3. John F. Wakerly, Digital Design Principles and Practices", Pearson Education, Asia, III Edition, 2003.

References

5. Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press,2011.
6. J. Bhasker, "A Verilog HDL Primer, Third Edition Hardcover", Star Galaxy Publishing; 3rd edition, 2005.
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 :

4. 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
5. 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

6. 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=EAEE66D704C273BA8004F8BFD5C95E49BB56FF0D4ACB324649EE1124C866FFB6B952BEC1BF49CD6F6BD5E180F07F18CF&originRegion=eu-west-1&originCreation=20220719080055

7.

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
Topics related to development of “ENTREPRENEURSHIP”: Robot Control System, Stepper motor control, servo motor control.
Topics Relevant to development of “ENVIRONMENT AND SUSTAINABILITY”: Robot Control System - Digital Design Platforms

Catalogue prepared by	Mrs Anupama Sindgi
Recommended by the Board of Studies on	BOS NO: 10th. BOS held on 17/01/2020
Date of Approval by the Academic Council	Academic Council Meeting No. 16, Dated 23/10/2021

Course Code: ECE3049	**Course Title:** **Developing Secure Embedded Systems** **Type of Course:** **Discipline Elective Theory**	**L- P- C**	3	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	10th BOS held on 17/01/2020
Date of Approval by the Academic Council	Meeting No. 16th, Dated 23/10/2021

Course Code: ECE 3050	**Course Title: Design for Testability** **Type of Course: Discipline Elective and theory only**	**L- P- C**	3	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	**This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques using VLSI testing tools.**				
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. 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.**					
Module 3	**Introduction to ATPG**	Assignment/Quizzes	Design Analysis	**10 Sessions**	
Topics: **Automatic Test Pattern Generation (ATPG) in DFT, ATPG classification, Combinational ATPG (e.g. D, PODEM, FAN), Sequential ATPG, ATPG STAGES,Fault models, Fault classes, Pattern**					

generation and simulation, simulations and debugging, Diagnosis flow and fault simulation.				
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, -Exhaustive Testing ,Delay Fault Testing,				

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.):

4. Lecture videos for design for testability: https://onlinecourses.nptel.ac.in/noc20_ee76
5. PPT on Design for Testability, Link : https://eecs.ceas.uc.edu/~jonewb/DFTnew.pdf
6. https://www.youtube.com/watch?v=MgCFUO2BrkQ
7. https://www.youtube.com/watch?v=MEaMm423t0w&list=PLZjlBaHNchvOFBWBAtAP9exwQgYpKqsO4
8. https://www.geeksforgeeks.org/design-for-testability-dft-in-software-testing/

9. https://web.stanford.edu/class/archive/ee/ee371/ee371.1066/lectures/lect_14.2up.pdf
10. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

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 related to development of “FOUNDATION SKILLS”: Introduction to DFT and Fundamentals of DFT Topics related to development of “EMPLOYABILITY”: Projects based on Various design for testability recently published research articles.Topics related to development of “ENVIRONMENT AND SUSTAINABILITY”: If chips are tested for any defects then the wastage of chips discarded due to defects will be reduced.

Catalogue prepared by	Ms Akshaya M Ganorkar
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3051	**Course Title: Machine Learning and Deep Learning using FPGA** **Type of Course: Program Core Theory**	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Comprehension of concepts/logics in Machine and Deep Learning Algorithms. Basics of VHDL code for Digital Logic Circuits using EDA tools. Basics of Python programming for Machine and Deep Learning Algorithms.				
Anti-requisites	**NIL**				
Course Description	**This course aims at the real time implementation of Machine Learning and Deep Learning Algorithms using the FPGA device. The course penetrates into the fundamentals of Artificial Intelligence concepts and the logical representation of the ML and DL algorithms. This course motivates towards the development of synthesizable VHDL code for classification, identification and regression using the ML and DL algorithms. The course provides the opportunity for FPGA based Real time implementable AI applications.**				
Course Objective	**This course is designed to improve the learners EMPLOYABILITY SKILLS by using PROBLEM SOLVING techniques in FPGA based Machine Learning and Deep Learning algorithm for real applications.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 10. Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. 11. Demonstrate the importance of VHDL in real time applications. **12.** Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. **13.** Analyze the developed artificial intelligence based VHDL code for power, area and delay using the FPGA device				
Course Content:					
Module 1	**Introduction to Machine Learning**	Quiz	Memory Recall based Quizzes	**11 session**	
Topics: Supervised Learning, Regression- Linear Regression, Ridge Regression, LASSO, Classifications of Supervised Learning: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, Perceptron, Logistic Regression, Unsupervised Learning- K-means Clustering, PCA.					
Module 2	**Digital Circuit Design**	Assignment / Quiz	Programming and Simulation task	**12 session**	
Topics: Introduction to VHDL Programming, Modeling styles in VHDL, Importance of Behavioral Modeling in Machine Algorithm, Development of Decision Tree Algorithm using VHDL, Validation of Synthesizable code for Machine Learning, Machine Learning based Data classification using VHDL, Machine Learning based Regression using VHDL					

Module 3	**Deep Learning**	Assignment	Analysis and Verification	**10 session**

Topics:
History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feed forward Neural Networks, Representation Power of Feed forward Neural Networks, Back propagation, Compensation Code for neural network using VHDL, Neural Network based Classification and Regression using VHDL, Real time application using Neural Network in FPGA.

Module 4	**Implementable Neural Networks**	Project	Application	**7 session**

Topics:
Application of Neural network in Stuck-at Fault analysis of Digital Circuits, Recurrent Neural Network for Power Converters Switching Faults, Neural Network for Image Classification, EDA tools used for Neural Network based Applications

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given case study on "Real Time Implementation of Artificial Intelligence using VLSI". Students will be submitting a report in appropriate format.

2. Presentation: Individual 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: The project work will be given on "Identification of Faults in Digital Circuits using ML and DL algorithms" and the students have to complete the work using the Cadence tools and documentation of the entire work in prescribed format to be submitted.

Assignment 1: Mixed Style VHDL modeling for Fixed Point Arithmetic.

Assignment 2: Weight optimization in Neural Network using Back propagation method

Text Book(s):

16. Deisenroth, Faisal and Ong, "Mathematics for Machine Learning", Cambridge University Press, 1st Edition, 2020. Link: https://mml-book.github.io/book/mml-book.pdf
17. Volnei A. Pedroni, "Circuit Design with VHDL", Third Edition, MIT press, 2020 https://www.penguinrandomhouse.com/books/657983/circuit-design-with-vhdl-third-edition-by-volnei-a-pedroni/

Reference(s):
Reference Book(s):

28. Mano, M. Morris and Ciletti Michael D., "*Digital Design*", 5th Edition, Pearson Education, 2020.
29. Oliver Theobald , "*Machine Learning For Absolute Beginners: A Plain English Introduction*", 2nd Edition, The author, 2017.

30. Andrew W. Trask, "*Grokking Deep Learning*", 1st Edition, Manning Publications, 2019.

31. Jayaram Bhasker, "*A VHDL Primer*", 3rd Edition, AT&T Publcaitions, 2003.

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

1. NPTEL Course on **"Digital System design with PLDs and FPGAs"** by Prof. Kuruvilla Varghese https://www.digimat.in/nptel/courses/video/117108040/L01.html
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:

4. 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
5. 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
6. 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
7. 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

Topics related to development of "FOUNDATION": Machine Learning and Deep Learning.
Topics related to development of "EMPLOYABILITY": Machine Learning and Deep Learning, HDL.
Topics related to development of "ENTREPRENEURSHIP": FPGA based Artificial Intelligence Products
Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Prediction and Regression in Real World Applications

Catalogue prepared by	**Dr. Joseph Anthony Prathap**, Associate Professor, SoE-ECE, Presidency University, Bengaluru
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3052</td><td colspan="3">Course Title:
Introduction to Embedded Machine Learning

Type of Course: General Basket Theory only</td><td>L-P-C</td><td>3</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">Comprehension of concepts/logics in Machine and Deep Learning Algorithms. Basics of Embedded Systems. Basics of Python programming for Machine and Deep Learning Algorithms.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">This course is designed to improve the learners “ENTREPRENEURIAL SKILLS” by using EXPERIENTIAL LEARNING techniques in Embedded Machine Learning using “TinyML”.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Overview of Machine Learning Algorithms</td><td>Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>14 session</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Module 2</td><td colspan="2">Overview of Embedded Devices for Machine Learning Algorithms</td><td>Assignment / Quiz</td><td colspan="2">Programming and Simulation task</td><td>12 session</td></tr>
<tr><td colspan="7">RISC and CISC Architectures, Introduction to ARM® Architecture and ARM® Cortex™-M TM4C123X processor, Comparing ARM® Cortex™-M TM4C123X processor with TM4C129X architecture, FPGA.</td></tr>
<tr><td>Module 3</td><td colspan="2">TinyML</td><td>Assignment</td><td colspan="2">Programming</td><td>19 session</td></tr>
<tr><td colspan="7">Fundamentals of TinyML, Need of TinyML, Advantages, Deploying TinyML, Factors to be considered while deploying TinyM.</td></tr>
</table>

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.

Project Work/Assignment:

1. **Case Studies:**
   Existing ML toolkits tend to be slow and consume memory, making them incompatible with real-time systems, limited hardware resources, or the rapid timing requirements of most embedded systems. We present our ML application, and the suite of optimizations we performed to create a system that can operate effectively on an embeddded platform. We perform an ablation study to analyze the impact of each optimization, and demonstrate over 20x improvement in runtimes over the original implementation, over a suite of 19 benchmark datasets. We present our results on two embedded systems.
   https://www.cs.cmu.edu/~khaigh/papers/2015-HaighTechReport-Embedded.pdf
2. **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:**
   Individual 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:**
   The project work will be given on the relevant topics from syllabus and the students have to complete the work using the Cadence tools and documentation of the entire work in prescribed format to be submitted.

Text Book(s):

18. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.

19. Pete Warden, Daniel Situnayake, "*TinyML*", 1st Edition, O'Reilly Media, Inc.

Reference Book(s):

32. Mano, M. Morris and Ciletti Michael D., "*Digital Design*", 5th Edition, Pearson Education, 2020.

33. Oliver Theobald , "*Machine Learning For Absolute Beginners: A Plain English Introduction*", 2nd Edition, The author, 2017.

34. 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.):

8. Harward University Course on **"TinyML"** https://pll.harvard.edu/course/fundamentals-tinyml?delta=0
9. NPTEL Course on **"An Introduction to Artificial Intelligence"** by Prof. Mausam, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs56/preview
10. 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
4. 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

Topics related to development of "FOUNDATION": Machine Learning and Deep Learning.
Topics related to development of "EMPLOYABILITY": Machine Learning and Deep Learning, HDL.
Topics related to development of "ENTREPRENEURSHIP": Factors to be considered while deploying TinyM, Case Studies Based on TinyML and Tensor Lite .

Catalogue prepared by	Ms.Natya.S
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Data Transfer Technologies Basket

Course Code: ECE3053	**Course Title: Data Communication and Networking** **Type of Course: Program Core, Theory Only**	**L- P- C**	3	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.** **The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real-world problems encountered in data communications and networking using various simulation tools.**				
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**	Quiz	Memory Recall based 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: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3054	**Course Title: MOBILE COMMUNICATION** **Type of Course: Discipline Elective** **Data Transfer Technologies & Theory only**	**L- P- C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**1) Analog Communication [ECE3006],** **2) Digital Communication[ECE3007]** **Basic concepts of Analog Modulation and Demodulation Techniques** **Basic concepts Digital modulation and Demodulation Techniques**				
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 OSI model and mobile ad-hoc network.				
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies by design and development of satellite systems.				
Course Content:					
Module 1	**INTRODUCTION TO MOBILE COMMUNICATION**	Quiz	Memory Recall based 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 Ad-Hoc NETWORK, TRANSPORT AND APPLICATION LAYER**	Quiz	Memory Recall based Quizzes	**10 Classes**
Topics: Ad-hoc network- features, topology, routing, OSI Model, Mobile TCP-, transmission/ time-out freezing, Application Layer				

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.

Project work/Assignment/Quiz:

Assignment 1:

Level 1: A service provider wants to provide cellular communication to a particular geographic area. The total bandwidth the service provider licensed is 5MHz and system subscriber requires 10 KHz of bandwidth. Determine the system capacity using frequency reuse techniques, if the service provider implements cellular system with 35 transmitter sites and cluster size of 7.

Level 2:

Consider a FDMA cellular system with 120 cites, a frequency reuse factor of N=12, and 900 overall two-way channels. Omni-directional antennas are used:

(a) What is the co-channel reuse ratio?

(b) Give the number of channels per cell, total number of channels available to the service provider, and the signal-to-interference ratio of the system.

Assignment 2:

Level 1: Summaries the features of various multiple access techniques used in wireless mobile communication. State the advantage and disadvantages of each technique.

Level 2: Design the Early AM wireless Transmitter system.

Assignment 3:

Level 1: Why GMSK is preferred for multiuser 2G cellular communication?

Level 2: Construct the GSM CODEC for speech communication considering the maximum frequency of 4KHz and sampling frequency of 8KHz, Downlink frequency is assumed to be 1800 MHz and the channel data of 256kbps.

Text Book(s)

1) Jochen Schiller, "*Mobile Communications*", Pearson Education, second edition, 2008.

2) William Stallings, "*Wireless Communications and Networks*", Pearson Education, second edition, 2002

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 Linkhttps://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
4. 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.Kaveh Pahlavan,Prasanth Krishnamoorthy, "*Principles of Wireless Networks*", Pearson Education, second 2008.

2. C.K.Toh, "*AdHoc Mobile Wireless Networks*", Pearson Education **,** first edition, 2003.

Topics related to development of "FOUNDATION SKILLS": Principles of Mobile Communication Systems.
Topics related to development of "EMPLOYABILITY": Wired and wireless network, Cellular Concepts
Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Operating Frequencies and its Radiation effects.

Catalogue prepared by	
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3055	**Course Title:** Satellite Communication **Type of Course:** Discipline Elective & Theory Only.	**L- P-C**	3	0	3
Version No.	1.0				
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	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies by design and development of satellite systems.				
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 Communication Services**	Assignment	Modeling Task, System Representation task	**12 Sessions**

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 development of "FOUNDATION SKILLS": Identity the different satellite systems. • Topics related to development of "EMPLOYBILITY": Design of spade systems, space link budget estimation and design of pico satellite. • Topics related to the development of "ENVIRONMENT ANDSUSTAINABILITY": Weather forecasting ,Radio and TV broadcast satellites, Military satellites and Navigation systems.	
Catalogue prepared by	Dr.M.S Divya Rani Mrs. Annapurna
Recommended by the Board of Studies on	BOS No: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3056	**Course Title: Wireless Communication and Networks** **Type of Course: Discipline Elective, Data Transfer Technologies Basket Theory Only**	**L- P- C**	**3**	**0**	**3**
Version No.	**2.0**				
Course Pre-requisites	Analog Communication, Digital Communication, Wireless Networks, Basic concepts of **communication system, modulation, demodulation, well acquainted with terms such 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 encountered in the design of wireless networks. The course includes the fundamentals of wireless communication and provides an overview of existing and emerging wireless communication networks. It covers fundamentals of cellular communications, multiple access technologies and various wireless networks including past and future generation networks. Further, the students will understand the basic concept of wireless system design and get familiar with various wireless networks. They will get the idea from the fundamentals of wireless communication and the evolution of wireless networks from first generation to LTE and LTE advanced after completion of this course.**				
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. **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 operation				
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 wireless 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 Session**
Topics: Channel assignment strategies, Capacity enhancement techniques, Interference and system capacity, Handoff, Trunking and grade of service. Introduction to multiple access, Frequency division multiple access, Time division multiple access, Code division multiple access and Spread spectrum multiple access.					
Module 3	**Multiple Antenna**	Project	Small hardware based		**08**

	Techniques			**Session**
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 Session**
Topics: Introduction to wireless Networks, Advantages and disadvantages of Wireless Networks, OSI model, WLAN topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of 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 device with any microcontroller, the embedded programming, SMS gateway simulator which can be used for testing purpose. Targeted Application: Communication, connection of devices by BLUETOOTH, Television and Radio Broadcasting, Radio Frequency Identification (RFID), Mobile Telephone System (Cellular Communication), Radar, Infrared Communication etc. 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:				
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 the 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 is 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 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): **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-A 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 enhancement techniques, Interference and system capacity, Handoff, Trunking and grade of service.

Catalogue prepared by	Ms. Maitraiyee Konar
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3057	**Course Title:** Radar Engineering **Type of Course:** Discipline Elective Theory only	**L- P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basic concepts of analog modulation and demodulation schemes and probability theory				
Anti-requisites	**NIL**				
Course Description	This is an advanced research-oriented course designed for undergraduate students. This course will enable students' 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	This course is designed to improve the learners' **EMPLOYABILITY SKILLS** by using **PROBLEM SOLVING** techniques.				
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: **Discuss** the working principle of CW and Frequency Modulated Radar. 4: **Compare** the principles of 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 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 Wireless Communications. file:///C:/Users/Admin/Downloads/Quantum_Antenna_Theory__EuCap2020_%20(1)%20(1).pdf

Topics Relevant to development of "FOUNDATION SKILLS": Radar Equation

Topics Relevant to development of "ENVIRONMENT AND SUSTAINABILITY": Power and operating frequency

Topics Relevant to development of "HUMAN VALUES AND PREFESSIONAL ETHICS": Applications of Radar

Catalogue prepared by	Ashwini B
Recommended by the Board of Studies on	**BOS NO: 15th. BOS held on 28/07/2022**
Date of Approval	**Academic Council Meeting No. 18th, Dated 03/08/2022**

by the Academic Council	

Course Code: ECE3058	**Course Title:** RF Engineering **Type of Course:** Discipline Elective Data Transfer technology Basket & Theory only		**L- P-C**	3	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. The basic analog and digital modulation techniques needed to translate signal 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 introduce RF components and architecture with applications. This course will enable the students to classify different active and passive components with design and noise considerations. This will also enable the students to seek employment opportunities, research and development activities in design of RF control circuit and various system architectures.**					
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) 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-Conversion Transmitter,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 a user friendly interface for the fast access to control high voltage electrical circuit operations using RF technology.
Assignment 1: Design, Visualize and compare matching network for one port load using Simulink.
Assignment 2: Implement RF metal oxide semiconductor device model on Matlab for different parameters.
Assignment 3: If the RF signal and the output IF is 2 MHz, determine all frequencies up to third-order harmonics that are generated by the mixer.
Assignment 4: Compare different Radio navigation systems with accuracy of position, Velocity Accuracy and Range of operation.

Text books:

1. Behzad Razavi , " RF Microelectronics ", Pearson Education ,6th Edition
2. Reinhold Ludwig,Gene Bogadanov ,"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).pptx.
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,Research article,Volume 6,Issue no.4 https://ieeexplore.ieee.org/abstract/document/8465897
2. Jasmine Jose Department 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 **" SKILL DEVELOPMENT "**: Introduction to RF Design, Active and Passive RF Components.
Topics relevant to "**ENVIRONMENT AND SUSTAINABILITY (ES)"**: RF frequencies.

Catalogue prepared by	**Mrs AKSHATHA K**
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic	Meeting No. 18th , Dated 03/08/2022

Council	

Course Code: ECE3059	**Course Title:** Security in Computer Networks **Type of Course:** Data Transfer Technologies and Theory only	**L- P- C**	3	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 are 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	**This course is designed to develop <u>ENTREPRENEURIAL SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques.**				
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, security mechanisms. Classical Encryption Techniques: Symmetric key cryptography Caesar cipher, mono alphabetic cipher, play fair cipher, hill cipher, poly alphabetic cipher, 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	Project Assignment	Programming and Simulation Task		**10 Classes**

	security			

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 Foundation Skills: Introduction to Network Security, Classical encryption techniques
Topics relevant to Employability: Data encryption algorithms and standards, security threats
Topics relevant to Human Values and Professional Ethics: Security threats and Security attacks.

Catalogue prepared by	**Mrs. Amrutha V Nair**
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3060	**Course Title: Wireless Adhoc Networks** **Type of Course: Discipline Elective, Data Transfer Technologies Basket Theory Only**	**L- P- C**	**3**	**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	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3061	**Course Title:** Optical Communication **Type of Course:** Discipline Elective Theory only		**L- P- C**	3	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 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) 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 Model Distribution 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	**9**	

			based 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 a Free 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

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.):

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

Research Papers :

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 development of "Foundation skills": Laser properties

Topics Relevant to development of "Employability": Fiber Optic Communication Systems

Catalogue prepared by	Dr. Balaji K A
Recommended by the Board of Studies on	BOS NO: 15th, BOS held on 28/07/2022

Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 20/08/2022

AI and Wearable Technologies Basket

Course Code: **ECE3062**	**Course Title: Fundamentals of Wearable Sensing** **Type of Course: Discipline Elective &Theory**	**L-P-C**	3	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.** The associated laboratory provides an opportunity to validate the concepts taught and enhances the ability to visualize the real system performance, using both hardware and simulation tools.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Fundamentals of Wearable Sensing and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING				
Course Outcomes	**On successful completion of the course students shall be able to:** 5. Demonstrate the concept of resistive and reactive sensors which can be applied for real life applications. 6. Understand the working principle of special purpose sensors and the need for developing smart sensors. 7. Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals. 8. Perform experimental study of various sensors.				
Course Content:					
Module 1	**Resistive and Reactive Sensors**	Assignment	Case study based		**08Classes**
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		**09Classes**
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 MEMSand 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. Fabricationofinterdigitated(IDE)electrodes**.**
2. Piezoresistive sensors for cuffless blood pressuremeasurement.
3. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.
4. Smarttextileforneurologicalrehabilitationsystem(NRS)
5. Epidermalelectronicssystem(EES)
6. 3Dimagingandmotioncapture
7. safety and security, navigation, Enhancing sportsmedia, Automatic digital diary
8. AIforrespiratorydiagnosticsand clinicaltrials.

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 "WearableElectronicsSensors-ForSafeandHealthyLiving",SubhasChandraMukhopadhyay,Springer2015

2M.MardonovaandY.Choi,"ReviewofWearableDeviceTechnologyandItsApplicationstothe MiningIndustry,"Energies, vol.11,p. 547,2018.

3

"Environmental,ChemicalandMedicalSensors",byShantanuBhattacharya,AKAgarwal,NripenChanda,Ashok PandeyandAshisKumarSen,SpringerNatureSingaporePteLtd.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 relevant to “EMPLOYABILITY”: Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, Health monitoring sensors 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3063**	**Course Title: Wearable Devices and its Applications** **Type of Course: Discipline Elective &Theory**	**L-P-C**	3	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 theneedfordevelopmentofwearable devicesanditsimplicationsonvarioussectors. It will also comprehendthedesignanddevelopmentofvariouswearableinertialsensorsandwearablebio-electrodeand physiological activitymonitoringdevices foruseinhealthcareapplications. The course will enable the students to become acquainted withvariouswearablelocomotivesensors asassistivedevicesfortrackingandnavigation. 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:** **9. Identifyandunderstandtheneedfordevelopmentofwearabledevicesandtheirinfluenceonvarioussectors.** **10. Discusstheapplicationsofvariouswearableinertialsensorsforbiomedical applications.** **11. Identifytheuseofvarious wearable locomotivetools forsafety, security and navigation.** **12. Designanddevelopvariouswearabledevicesfordetectionofbiochemicalandphysiological body signals, environmental monitoring, safety and navigational assistivedevices.**				
Course Content:					
Module 1	**IntroductiontoWearableDevices**	Quiz	Memory Recall based Quiz	**09 Classes**	
Topics: Motivation for development of Wearable Devices, The emergence of wearable computing andwearableelectronics,Typesofwearablesensors: Invasive,Non-invasive; Intelligentclothing,Industrysectors'overview– sports,healthcare,Fashionandentertainment,military,environment monitoring,miningindustry,publicsectorandsafety.					
Module 2	**WearableInertialSensors**	Assignment	Case study based	**08Classes**	
Topics: WearableInertialSensors-Accelerometers,GyroscopicsensorsandMagneticsensors;ModalityofMeasurement-WearableSensors,InvisibleSensors,In-ShoeForceandPressureMeasurement;Applications:FallRiskAssessment,FallDetection,GaitAnalysis,Quantitative					

Evaluation of Hemiplegic and Parkinson's Disease patients.Physical Activity monitoring: HumanKinetics,CardiacActivity,EnergyExpendituremeasurement: 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: MEMSmicrophones,Bioacoustics,MicrophonesandAIforrespiratorydiagnosticsand clinicaltrials.
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	Small hardware based	**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:

9. Fabricationofinterdigitated(IDE)electrodes**.**
10. Piezoresistive sensors for cuffless blood pressuremeasurement.
11. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.
12. Smarttextileforneurologicalrehabilitationsystem(NRS)
13. Epidermalelectronicssystem(EES)
14. 3Dimagingandmotioncapture
15. safety and security, navigation, Enhancing sportsmedia, Automatic digital diary
16. AIforrespiratorydiagnosticsand clinicaltrials.

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"WearableElectronicsSensors-ForSafeandHealthyLiving",SubhasChandra Mukhopadhyay,Springer2015

2 M**.**MardonovaandY.Choi,"ReviewofWearableDeviceTechnologyandIts Applicationstothe MiningIndustry,"Energies, vol.11,p. 547,2018.

3"Environmental,ChemicalandMedicalSensors",byShantanuBhattacharya,AKAgarwal,NripenChanda,AshokPandeyandAshisKumarSen,SpringerNatureSingaporePteLtd.

<table>
<tr><td>2018

4M.MardonovaandY.Choi,"ReviewofWearableDeviceTechnologyandIts Applicationstothe MiningIndustry,"Energies, vol.11,p. 547,2018.
Online Lectures:
7. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK
8. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT
9. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home
Website:
1. https://nptel.ac.in/courses/112/107/112107289/
2. https://nptel.ac.in/courses/112/105/112105249/
3. https://www.intechopen.com/chapters/66880

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</td></tr>
<tr><td>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.</td></tr>
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Catalogue prepared by	Ms. Amrutha V Nair
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3064	**Course Title:Embedded Platforms for Wearables** **Type of Course: Discipline Elective, AI and Wearable Technologies, Theory only**		**L-P-C**	3 0	3
Version No.	2.0				
Course Pre-requisites	**Microprocessor, Microcontroller, Fundamentals of Wearable Sensing**				
Anti-requisites	**NIL**				
Course Description	**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.**				
Course Objective	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				
Course Outcomes	**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				
Course Content:					
Module 1	Introduction to Wearable Embedded Systems	Quiz	Memory Recall based Quizzes	**06session**	
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.					
Module 2	Wearable Embedded Architectures	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**10 session**	
Topics: Features of ARM Cortex Series, Comparison of ARM Cortex-M and Cortex-A architectures, addressing modes, ARM instruction set for ARM Cortex.					
Module 3	Programming Embedded Architecture and Interfacing	Assignment / Quiz	Programming and Simulation task / Memory Recall based Quizzes	**12 session**	
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.					
Module 4	Case Studies	Assignment	Programming Assignment	**12 session**	
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):

20. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 1st edition
21. Frank Vahid, Tony Givargis, "Embedded System Design: Unified Hardware/Software Design", John Wiley & Sons,2nd Edition,

Reference(s):

Reference Book(s):

9. Enzo Pasquale Scilingo, Gaetano Valenza, "Wearable Electronics and Embedded Computing Systems for Biomedical Applications", MDPI AG, Switzerland, 1st Edition
10. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition
11. ARM Cortex Datasheet available on (https://www.arm.com/)

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

11. Online NPTEL course :- https://onlinecourses.nptel.ac.in/noc22_ee12/preview
12. Notes:https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/third-party/ddi0100e_arm_arm.pdf
13. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html
14. https://presiuniv.knimbus.com/user#/home

E-content:

49. 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
50. 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#!
51. 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
52. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3065**	**Course Title:** **RFID and Flexible Sensors** **Type of Course:** **Discipline Elective& Theory only**		**L-P-C**	3	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	The objective of the course is to familiarize the learners with the concepts of RFID and Flexible Sensors and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
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-Sensorfor 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 relevant to "EMPLOYABILITY": Applications of RFID technology and Materials for flexible electronics 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: **ECE3066**	**Course Title: Wireless Technologies for Wearables** **Type of Course: Discipline Elective & Theory only**	**L- P- C**	3	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 5. Identify the use of various wearable locomotive tools for safety and security, navigation. 6. Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.				
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**

Assignment-1: Study of Wearable EEG electrodes: Design and measurement of electrical activity of brain.
Assignment-2. Study of Wearable EMG electrodes: Design and measurement of electrical activity of muscle cells.
Assignment-3: Study of Wearable motion sensors using textile based MEMS accelerometer

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.):

53. 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 >
54. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088>
55. Case studies on Wearable technology<https://www.hticiitm.org/wearables>

E-content:

1. 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.

2. Muhammad Mahtab Alam,"Wearable Wireless Sensor Networks: Applications, Standards and Research Trends"Jan 2015 http://dx.doi.org/10.1201/b20085-6.

3. 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.

4. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3067	**Course Title:** Wearable Internet of Thing **Type of Course: Discipline Elective** AI & Wearable Technologies Theory Only	**L - P- C**	**3**	**0**	**3**
Version No.	2.0				
Course Pre-requisites	1] Micro Controller Applications(ECE3014)				
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: 5) Design IoT end points for wearable applications. 6) Identify the suitable materials and its processing for the development of thin film electronics. 7) Analyze the appropriate protocols, wireless techniques for the problem. 8) Develop algorithms for wearable system and modeling of wearable system.				
Course Content:					
Module 1	**Wearable devices andRole of IoT in wearable devices**	**Assignment / Quizzes**	**Memory Recall based Quizzes**	**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**	**10Sessions**

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:

6) **Project Assignment: Development of IoT enabled - Smart watch, Cameras, Fitness meter etc.**
7) **Assignment 1: Interface Arduino to Zigbee module.**
8) **Assignment 2: Interface LED and Temperature sensor to Raspberry pi.**
9) **Assignment 3: Interface stepper motor to Raspberry pi.**
10) **Assignment 4: Interface camera to Raspberry pi.**

Text Book(s):

4. **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.**
5. **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 Mrs. Pallabi Kakati
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3068	**Course Title: Embedded Intelligence in WIoT** **Type of Course: Discipline Elective, General Basket Theory only**		**L-P-C**	3	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:

1. 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 .**

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

Text Book(s):

22. Fundamentals of IoT and Wearable Technology Design : Haider Raad , Wiley
23. 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.):

14. Free online self-paced course :-Introduction to IoT and Embedded systems - https://www.coursera.org/learn/iot
15. Online notes :- https://www.epcgroup.net/embedded-intelligence/
16. NPTEL online video content:-https://nptel.ac.in/courses/106/105/106105166/
17. Online ppts :- https://www.slideshare.net/jaswindersinghthind/a-basic-ppt-on-internet-of-thingsiot
18. Online ppts:-https://www.edureka.co/blog/iot-tutorial/
19. https://presiuniv.knimbus.com/user#/home

E-content:

20. 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
21. 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
22. 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
23. *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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3069	**Course Title:** Flexible Electronics And Sensors **Type of Course: Discipline Elective** **VLSI and Embedded Systems Basket** **Theory Only**	**L-P-C**	3	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 5**. Acquire** the design knowledge for developing wearable sensors for physical and chemical parameters 6**. Gain** the competency in transferring the conducting and semiconducting fibers to smart textiles				
Course Content:					
Module 1	**Overview of flexible electronics technology**	Case study / quiz	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 / quiz	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 / quiz	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 from foils to textiles & Wearable Bio, Chemical and Inertial sensors	Case study / quiz	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):

5. 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):

7. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge.
8. Kate Hartman, “Make: Wearable Electronics: Design, prototype, and wear your own interactive garments”, 2014, 1st Edition, Marker Media, Netherlands.
9. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 2015, 1st Edition, World Scientific Publishing Co, Singapore.
10. 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 .

3. Marc Aliqué,Claudia Delgado Simão,Gonzalo Murillo,Ana Moya"Fully-Printed Piezoelectric Devices for Flexible Electronics Applications" in **Advanced Materials Technogolies**First published: 25 January 2021. **https://doi.org/10.1002/admt.202001020**. https://onlinelibrary.wiley.com/doi/abs/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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3070	**Course Title:** AI& Digital Health **Type of Course:** Theory	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Introduction to computer science, database management system.				
Anti-requisites	**NIL.**				
Course Description	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.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of AI& Digital Health and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.				
Course Outcomes	**On successful completion of this course the students shall be able to:** (i) Explain basic principles of AI & Digital Health. (ii) Understand the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning. (iii) Illustrate object-oriented concepts. (iv) Develop database and GUI applications.				
Course Content:					
Module 1	THE BASICS OF ARTIFICIAL INTELLIGENCE	Quiz	Memory Recall based Quizzes	**10 Hours**	
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					
Module 2	APPLYING ARTIFICIAL INTELLIGENCE IN HEALTHCARE	Assignment/ Quiz	Conceptual Descriptive	**10 Hours**	
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.					
Module 3	CHALLENGES OF ARTIFICIAL INTELLIGENCE	Assignment/ Quiz	Programming & Simulation	**14 Hours**	
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?					
Module 4	FUTURE OF HEALTHCARE	Assignment/ Quiz	Conceptual Descriptive	**6 Hours**	
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:

5. **https://www.coursera.org/learn/introduction-to-digital-health**
6. **https://ocw.mit.edu/courses/health-sciences-and-technology/hst-947-medical-artificial-intelligence-spring-2005/**
7. **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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3071	**Course Title:** Wearable and Ubiquitous Computing **Type of Course:** Discipline Elective, Theory Only	**L-P-C**	3	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 IoT and data analytics**	Assignment	Theoretical Understanding	**9 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3069	**Course Title:Secure Wearable Internet of Things** **Type of Course: Open Elective, Theory only**	**L- 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**	Assignment	Case studies	**10 Sessions**		

	platforms			
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	Wearables and IoT in Entertainment, Gaming, Fitness, sports and industry	**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	15th BOS held on28/07/2022			

of Studies on	
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3070	**Course Title:** Wearable Prosthetics and Robots **Type of Course: Discipline Elective, IoT Basket Theory Only**		**L-P-C**	3	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 course develops a 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 by the Board of Studies on	15th BOS held on28/07/2022

Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3074	**Course Title:** Applications of Brain Computer Interfaces **Type of Course:** Discipline Elective	**L-P-C**	3	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.):

35. Prof. Mahesh Jayachandra's NPTEL Lecture Notes and Videos on Introductory Neuroscience & Neuro-Instrumentation (IISc Bangalore): https://nptel.ac.in/courses/108108167
36. 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
37. 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/"
38. 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
39. Brain Computer Interface w/ Python and OpenBCI for EEG data:https://www.youtube.com/watch?v=Dgo7F-lpyYE
40. Dr. Kunal Pal's Video lectures on "Biomedical Signal Processing" from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8

E-content:

56. 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
57. 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

58. 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
59. 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
60. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

IOT and Sensor Technologies Basket

<table>
<tr><td>Course Code:
ECE3075</td><td colspan="3">Course Title:IoT: Architecture and Protocols

Type of Course: Discipline Elective, Theory Only</td><td>L-P-C</td><td>3</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">NIL</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 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</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of IoT: Architecture and Protocols and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:

vi) Discuss the various types of IoT architectures.
vii) Explore various cloud based architecture.
viii) Discuss various types of communication protocol used in IoT applications.
ix) Design a IoT based application .</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">IoT Architecture & components</td><td>Assignment/ Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">12 Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Data management</td><td>Assignment/ Quiz</td><td colspan="2">Real time Application Project</td><td colspan="2">12 Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 3</td><td colspan="2">Communication in IoT</td><td>Assignment/ Quiz</td><td colspan="2">Memory Recall based Quiz</td><td colspan="2">11 Sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8">List of Laboratory Tasks:</td></tr>
</table>

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 RaspberiPi

Text Book(s):

1. SudipMisra, ,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 Gondhi2018 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.-2022Internet 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 "EMPLOYABILITY SKILLS": Industry 4.0 and IoT for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Renuka Bhagwat
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of	Meeting No. 18th, Dated 03/08/2022

Approval by the Academic Council	

Course Code: ECE3076	**Course Title:** IoT Platforms and Application Development **Type of Course:** Discipline Elective, Theory Only	**L- P- C**	3	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:** (i) **Explain** the need and requirement for IoT Protocols. (ii) **List** the most popular platforms on which IoT is employed. (iii) **Identify** the networking requirements for a given IoT application. (iv) **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

8. 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

9. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3077	**Course Title:Wireless Protocols for IOT** **Type of Course: Discipline Elective, General Basket** **Theory only**	**L-P-C**	3	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 for IoT	Assignment	Programming Assignment	**17 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):

24. Raj Kamal, "Internet of Things-Architecture and design principles, 2nd Edition, McGraw Hill Education, 2022.
25. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3078	**Course Title: IoT and Cloud Computing** **Type of Course: Discipline Elective and Theory course only**	**L- P- C**	**3**	**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 (PaaS)	Assignment / Quiz	Implementation using Simulation Tools		**12 sessions**
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 .**

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

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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3079	**Course Title: Fog Computing** **Type of Course: Program Core Theory**	**L-P-C**	3	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: 4. Illustrate the concepts of fog computing in communication technology 5. Develop the fog computing based IoT application by using integrated architectural model 6. Make use of advanced fog computing concepts in health monitoring and smart transportation applications. 7. 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.):

1. NPTEL Video lectures on “Fog Computing” by Prof. Dr. Sudip Misra”, IIT Kharagpur, (560) FOG COMPUTING- I - YouTube, (560) FOG COMPUTING- II - YouTube
2. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3080	**Course Title: IOT Edge Nodes and its Applications** **Type of Course : Theory**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basic concepts of Real Time Operating Systems, Embedded Systems, and C /C++ skills.				
Anti-requisites	**NIL**				
Course Description	**This course provides insights into the fundamentals of IOT based systems that develop the knowledge of both hardware and software to design and implementation Real time automated Applications in industrial level. The course emphasizes on the IOT node technology, highlighting the practical methodology, verification through testability in real time applications. The course also demonstrates the use of software languages and tools that supports to design for high level simulation and synthesis.**				
Course Objective	The objective of the course is to familiarize the learners with the concepts of IOT Edge Nodes and its Applications and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING				
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. Demonstrate** the computing types and highlight its importance in edge computing **3. Illustrate** the Technical design constraints needed in the IOT. **4. Analyze** the implementable edge computing based Internet of things **5. Utilize** the IOT platforms and understand the hardware deployment for IoT.				
Course Content:					
Module 1	**Industrial IOT Introduction IIoT Architecture**	Quiz	Memory Recall based Quizzes		**10 session**
Topics: Components of IIOT - Sensors, Interface, Networks, Key terms – IOT Platform, Interfaces, API, clouds, Data Management Analytics, Sustainability through Business excellence tools Challenges Various Architectures of IOT and IIOT, Advantages & disadvantages, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT					
Module 2	**Challenges in Federating Edge Resources**	Assignment/ Quiz	Memory Recall		**10 session**
Topics: Relevant Technologies of Edge Computing ,Cloud-Hierarchy of Edge Computing-Business Models-Opportunities and Challenges ,Challenges in Federating Edge Resources ,Methodology-Integrated C2F2T Literature by Modeling Technique-Integrated C2F2T ,Literature by Use-Case Scenarios-Integrated C2F2T,Management and Orchestration of Network Slices in 5G, Edge, and Clouds					
Module 3	**Gateway Network and Challenges in IoT**	Assignment/ Quiz	Analysis and Verification		**10 session**
Topics: Implementation of IoT Edge Gateway; Edge Architecture: CloudPath; A Multi-Tier Cloud Computing Framework Femto Clouds; Leveraging Mobile Devices to Provide Cloud Service at the Edge Fast; Scalable and Secure Onloading of Edge Functions Using Air Box, computational resources- Data-storage. Virtualization concepts - Types of Virtualization Introduction to Various Hypervisors - High Availability					

(HA)/Disaster Recovery (DR) using Virtualization.				
Module 4	**Developing IoT Solutions and Domain specific applications**	Assignment/ Quiz	Application	**10 session**
Topics: Introduction to IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Edge Analytics, Edge Security and Artificial Intelligence(AI). Home automation; Industry applications; Surveillance applications; Other IoT applications.				
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.

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. Cao, Jie, Zhang, Quan, Shi, Weisong, “Edge Computing: A Primer”,5th Edition, Pearson Education, Springer, 2018
4. Rajkumar Buyya, Satish Narayana Srirama, “Fog and Edge Computing: Principles and Paradigms”, 1st Edition, Wiley, 2019

Reference(s):

5. David Boswarthick, “M2M Communications – A Systems Approach”, 1st Edition, Wiley, USA, 2012.
6. Waltenegus Dargie,Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice” , 1st Edition, Wiley Publications 2010
7. Dr. Ovidiu Vermesan, Dr. Peter Friess , “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems” , 1st Edition, River Publishers 2013.
8. 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.):

10. **NPTEL Course on "Introduction to internet of things", Prof. Sudip Misra, IIT Kharagpur, https://nptel.ac.in/courses/106/105/106105166/**
11. **NPTEL Course on "Design for internet of things", By Prof. Prabhakar T V, IISc Bangalore, https://onlinecourses.nptel.ac.in/noc21_ee85/preview**
12. **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**
13. **Free online self-paced course :- https://open.cs.uwaterloo.ca/python-from-scratch/**
14. **Online notes :- https://open.cs.uwaterloo.ca/language-independent-lessons/**

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

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 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

Topics related to development of “EMPLOYABILITY”: Developing applications through IoT tools for developing Employability skill 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code:ECE3081	**Course Title:** **Security and Privacy in Traditional IoT Systems** **Type of Course: Discipline Elective Theory**	**L-P-C**	3	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 Models**	Assignment	System Design Based	**12 Classes**

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 by	Nipun Sharma
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3082</td><td colspan="3">Course Title: Data Science for IOT
Type of Course: Program Core IOT Basket Theory</td><td>L-P-C</td><td>3</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">Basic concepts of Microprocessor programming and memory interfacing, knowledge of Python and Embedded C.</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 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 encourages students to become entrepreneurs to launch new products in IOT and Data Science.</td></tr>
<tr><td>Course objective</td><td colspan="7">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals of IOT</td><td>Assignment/Quiz</td><td colspan="2">IOT architectures, Frameworks and M2M</td><td>15Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Data Handling& Analytics</td><td>Project</td><td colspan="2">Data Analysis task</td><td>15Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 3</td><td colspan="2">Applications of IOT</td><td>Assignment</td><td colspan="2">IOT and Data Science. Real time applications</td><td>10Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
</table>

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):

6. HakimaChaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN: 978-1- 84821-140-7, Wiley Publications.Edition-1
7. Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", Wiley Publications. Edition-2

References:

11. 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 Du324, 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 prepared by	Dr. K BhanuRekha Ms. R Anusha
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the	Meeting No. 18th, Dated 03/08/2022

Academic Council	

Course Code: ECE3083	**Course Title: Hardware and Software Architecture for secured IoT Systems** **Type of Course: Discipline Elective Theory**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Basic understanding of communication protocol stack. 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**	Assignment	Simulation Tasks	**12 Classes**	

	and Web of Things			
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	15th BOS held on28/07/2022

by the Board of Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3084	**Course Title: Mobile App Development for IoT** **Type of Course: Elective Theory and & Integrated Laboratory**.	**L- P-C**	2	2	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	Assignment	Memory Recall	**7 sessions**	

	Mobile Applications		based Quiz	
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 :

7. 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

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

11) 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 "Internet of Things A pproac 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: 15th, Dated BOS 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE 3085	**Course Title: Security and Privacy in Edge Native Solutions** **Type of Course: Discipline Elective Theory**	**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 NETWO**	Assignment	Memory Recall based Quizzes	**12 Classes**		

	RK AND PROTOCOLS for IoT			
Topics: Application layer Protocols for security IETFs CoAP, IBMs MQTT, XMPP, AMQP, Transport Layer: UDP, DTLS, TCP, Network Layer.			**IPv4/IPv6, RPL, 6LoWPAN (adaption)**	
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	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code:

ECE3086</td><td colspan="3">Course Title: Industrial Internet of Things (IIoT)

Type of Course: Discipline Elective / Theory Only</td><td>L- P- C</td><td>3</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">Basic concepts of Internet of Things</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of Industrial Internet of Things (IIoT) and attain SKILL DEVELOPMENT through <u>PARTICIPATIVE 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:

5. Demonstrate the importance of Industrial IoT and its layers.
6. Illustrate the role of data analytics and machine learning in IIoT.
7. Ability to identify, formulate and solve problems by using Industrial IoT.
8. Make use of the concepts of IIoT in real applications.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction</td><td colspan="2">Assignment</td><td colspan="2"></td><td>10 Sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 2</td><td colspan="2">IIoT Layers</td><td colspan="2">Assignment</td><td colspan="2"></td><td>9 Sessions</td></tr>
<tr><td colspan="8">Topics: Industrial IoT- Layers: IIoT Communication, IIoT Networking. Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science.</td></tr>
<tr><td>Module 3</td><td colspan="2">IIoT Data Monitoring and Control</td><td colspan="2">Assignment</td><td colspan="2"></td><td>10 Sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 4</td><td colspan="2">Application Domains</td><td colspan="2">Assignment</td><td colspan="2">Case Study</td><td>10 Sessions</td></tr>
<tr><td colspan="8">Topics: Industrial 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</td></tr>
<tr><td colspan="8">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</td></tr>
</table>

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 relevant to “EMPLOYABILITY SKILLS”: Plant Safety and Security (Including AR and VR safety applications), Facility Management for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Srilakshmi K H
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/7/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3087	**Course Title:** IoT Robots **Type of Course: Discipline Elective from Signal Processing Basket Theory only**	**L- P- C**	3	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	**The objective of the course is to familiarize the learners with the concepts of IoT Robots and attain SKILL DEVELOPMENT through <u>PARTICIPATIVE LEARNING</u> 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 drive 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 "EMPLOYABILITY SKILLS": Use of IoT in Robot, Relevance of IoT for the future 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 NO: 15th BOS held on 28/7/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3088	**Course Title: Internet of Medical Things (IoMT)** **Type of Course: Program Core IoT Basket**	**L- P- C**	3	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 <u>PARTICIPATIVE LEARNING</u> 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: 15th, Dated BOS 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

OPEN ELECTIVE

Course Code: **ECE1003**	**Course Title: Fundamentals of Electronics** **Type of Course: School Core** **Theory**	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**NIL**				
Anti-requisites	**Elements of Electronics Engineering (ECE1001); Analog Electronics (ECE2001), Digital Electronics (ECE2002)**				
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

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. 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

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

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: 15th, Dated BOS 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE1004	**Course Title:** Microprocessor based Systems **Type of Course:** Open Elective &Theory Only	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	NIL				
Anti-requisites	Microprocessor Programming and Interfacing (ECE3003)				
Course Description	**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.**				
Course Objective	The objective of the course is to familiarize the learners with the concepts **of Microprocessor based Systems** and attain **ENTREPRENEURIAL SKILLS** through **PARTICPATIVE LEARNING.**				
Course Outcomes	**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.**				
Course Content:					
Module 1	Fundamentals of Digital Systems and Microprocessors	Quiz	Memory Recall based Quizzes	**10Sessions**	
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.					
Module 2	8086 Instruction Sets and Assembly Language Programming	Assignment / Quiz	Programming and Simulation task	**12 Sessions**	
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.					
Module 3	Introduction to Interfacing Techniques	Assignment	Memory Interfacing Task and Analysis	**10 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.):

6. The Intel Microprocessors: Architecture Programming and Interfacing book by Barry B. Brey, Eighth Edition <https://userpages.umbc.edu/~squire/intel_book.pdf>
7. Microprocessors Lectures adapted from slides and the textbook materials of Dr. Kip Irvine <https://www.philadelphia.edu.jo/academics/qhamarsheh/page.php?id=13>
8. Documentation for Emu8086 <https://www.philadelphia.edu.jo/academics/qhamarsheh/uploads/emu8086.pdf>
9. Microprocessors and Interfacing NPTEL Video Lectures <https://nptel.ac.in/courses/108/103/108103157/>
10. x86 Assembly Language Programming <https://cs.lmu.edu/~ray/notes/x86assembly/>

E-content:

61. 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
62. 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
63. Sima, Dezsö. "Decisive aspects in the evolution of microprocessors." Proceedings of the IEEE, vol. 92, no. 12 (2004), pp. 1896-1926. https://ieeexplore.ieee.org/document/1360164
64. 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
65. Radhakrishnan, Kaladhar, Madhavan Swaminathan, and Bidyut K. Bhattacharyya. "Power delivery for high-performance microprocessors—challenges, solutions, and future trends." IEEE Transactions on Components, Packaging and Manufacturing Technology, vol. 11, no. 4 (2021), pp. 655-671.

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9377004.

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

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.

Catalogue prepared by	Mrs. Priyanka Ray
Recommended by the Board of Studies on	**BOS Meeting NO: 15th, Dated BOS 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE1005	**Course Title: Journey of Communications** **Type of Course: Open Elective: Theory Only**	**L-P-C**	3	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 appreciate the need for fundamentals of communications systems and basics of designing simple communication systems.The course progress with the element of communication systems, types of communication, electromagnetic waves, need for modulation, basic types of Modulation: Amplitude Modulation & Frequency Modulation. Different Types of receivers, discussion on Practical Frequency Modulation, Internet, FAX, Mobile telephony Emerging of Digital technology, Various multiplexing schemes and its applications. Application of the course includes conceptual orientation, theoretical framework and analysis, and Practical RF system design.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Journey of Communications and attain ENTREPRENEURIAL SKILLS through PARTICPATIVE LEARNING.				
Course Outcomes	**On successful completion of this course the students shall be able to:** **1) Discuss on the evolution of communication systems** **2) Summarizes the need for modulation and its types.** **3] Demonstrate AM and FM Modulation and Demodulation Process** **4] Compare the analog communication with Digital Communication Systems.**				
Course Content:					
Module 1	**Basic Terminology of Communication System**	**Assignment**	**Modeling Task, System Representation task**	**12 classes**	
Topics: History of Communication Systems: Transmission of Information:, Elements of Communication Systems, basic terminology used in electronic communication systems, bandwidth of signals, Source of signal transmission, bandwidth of transmission medium, Electromagnetic Spectrum. Communication Channels. Analog and Digital Types of Communication. Difference between Wireless communication and Wireline Communication, Application at Various Bands of Frequencies.					
Module 2	Electromagnetic Wave Analysis	Practical Assignment	Simulation and Signal analysis task	**12 classes**	
Topics: shannon's channel capacity ,propagation of electromagnetic waves , ground waves, sky wave, space waves. modulation and its necessity, physical transmission media, networks: LAN,PAN,WAN, moorse code and its properties, development of first wireless telegraphy, numericals examples. practical applications: internet, fax, mobile telephony.					
Module 3	Transceivers Modelling	Case Study	Simulation/Signal Analysis task	**9 classes**	
Topics: Amplitude Modulation, Analog AM Amateur Radio. Frequency Modulation, Receiver type: Tuned radio-					

frequency (TRF) receiver, Superheterodyne receiver.AM Receivers, FM Receivers .Numerical Examples				
Module 4	Concepts of Digital Technology	Assignment	Simulation/Signal Analysis task	**9 classes**

Topics:
Sampling theory and practices, digital technology, digital fundamentals ,the binary number system ,digital electronics, fundamentals of data communications systems ,the emergence of data communications systems ,characteristics of data transmission circuits, digital codes, multiplexing - frequency-division multiplex time-division multiplex, elements of long-distance telephony.

Text Book(s):

1. **B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, New York, 2009. ISBN 978-0-19-533145-5**
2. **Simon Haykin and Michael Moher, Communication Systems, 5 th Edition, John Wiley and Sons, Inc., New York, 2009. ISBN 978-0-471-69790-9**

Reference Books:

1. Dennis Roddy and John Coolean, "*Electronic Communications*", PEA
2. Robert J. Schoenbeck, "*Electronic Communication Systems - Modulation and Transmission*", PHI

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

1. https://youtu.be/iZM2zgxnEOc
2. https://www.sciencedirect.com/topics/engineering/analog-communication
3. https://nptel.ac.in/courses/117105143
4. https://www.slideshare.net/prestonking948/analog-communication

E-content:

1. R. Boddeda, S. Almonacil, D. R. Arrieta and S. Bigo, "Analog/Digital Converter Requirements for Coherent Optical Satellite Communications," 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC), 2022, pp. 1-3, doi: 10.23919/OECC/PSC53152.2022.9850076.
https://ieeexplore.ieee.org/document/9850076

2. A. Mezerins and V. Bespal'ko, "Estimation of analog-to-time and time-to-digital conversion efficiency in analog optical communication system testbed," 2015 Advances in Wireless and Optical Communications (RTUWO), 2015, pp. 211-214, doi: 10.1109/RTUWO.2015.7365754.
https://ieeexplore.ieee.org/document/7365754

3. Y. Feng et al., "A 20.8-Gbps dual-carrier wireless communication link in 220-GHz band," in China Communications, vol. 18, no. 5, pp. 210-220, May 2021, doi: 10.23919/JCC.2021.05.013.
https://ieeexplore.ieee.org/document/9444247

4.K. Onohara, J. Nishioka, T. Yoshida and N. Suzuki, "A Study of Multi-Channel Analog-to-Digital Conversion for Beyond-5G Mobile Fronthaul," 2020 Opto-Electronics and Communications Conference (OECC), 2020, pp. 1-3, doi: 10.1109/OECC48412.2020.9273574.

https://ieeexplore.ieee.org/document/9273574

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

Topics relevant to "ENTREPRENEURIAL SKILLS": Amplitude and angle modulation techniques, fundamentals of data communications systems, FDM, TDM for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

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

by the Academic Council	

Course Code: ECE3089	**Course Title: Artificial Neural Networks** **Type of Course: Open Elective** **Theory**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**NA**				
Anti-requisites	Computational Intelligence and Machine Learning (ECE3015)				
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. It is intended at introducing basic concepts to Non ECE and CSE students.**				
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:

NA

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):

5. 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	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3090	**Course Title: Digital System Design using VERILOG** **Type of Course: Discipline Elective, General Basket Theory only**	**L- 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 Session**
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

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:

4. **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.**

Sample Assignment 1: Design a cyclic redundancy Checker using Verilog. Compare the power and area consumption for the code using two different approaches. Design and implement in Xilinx-VIVADO. Also perform debugging using the available tools.

Sample Assignment 2: How to interface a mouse with Basys 3 FPGA in Verilog

Sample Assignment 3: Design a real time traffic control system using Verilog.

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 .**
6. **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) 4. Verilog HDL based FPGA design | IEEE Conference Publication | IEEE Xplore 5. Towards Optimised FPGA Realisation of Microprogrammed Control Unit Based FIR Filters | IntechOpen 6. Improvisation of Gabor Filter design using Verilog HDL | IEEE Conference Publication | IEEE Xplore 7. Behavioral modeling and simulation of analog/mixed-signal systems using Verilog-AMS | IEEE Conference Publication | IEEE Xplore 8. Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language | IEEE Conference Publication | IEEE Xplore 9. 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: 15th, Dated BOS 28/07/2022
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE3091	**Course Title: Mathematical Physics** **Type of Course: Open elective**	**L- P-C**	3	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 to familiarize the learners with the concepts of Mathematical Physics and attain SKILL DEVELOPMENT through PROBLEM SOLVING techniques**				

<table>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

1. Solve ordinary and partial differential equations.
2. Demonstrate the applications of partial differential equations encountered in physical problems.
3. Apply the concepts of Green's function in solving PDEs related to problems pertaining to electrical and mechanical engineering.
4. Analyze the concepts of complex calculus and functions in advanced formulation.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Ordinary and Partial Differential equations</td><td>Assignment/Quiz</td><td>Problem Solving</td><td>12 Classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 2</td><td>Applications of partial differential equations in physics and engineering</td><td>Assignment/Quiz</td><td>Simulation</td><td>10 Classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 3</td><td>Green's function</td><td>Assignment</td><td>Simulation</td><td>8 Classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Complex analysis</td><td>Assignment</td><td>Problem Solving</td><td>12 Classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
<tr><td colspan="5">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 .</td></tr>
<tr><td colspan="5">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</td></tr>
</table>

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

3. 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
4. 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
5. 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 relevant to “ENTREPRENEURIAL SKILLS”: Applications of partial differential equations in physics and engineering for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Sumantra Chaudhuri Assistant Professor, ECE-SoE Presidency University, Bengaluru
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3092	**Course Title: Photonic Integrated Circuits** **Type of Course: Discipline Elective Theory**.	**L- P-C**	3	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 to familiarize the learners with the concepts of Photonic Integrated Circuits 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 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	Photonic Crystal Structures	Assignment		Comprehension based Quizzes and	**8 sessions**

				assignments	

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

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.):

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**

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**

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 **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Dr Balaji ka
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE 3093	**Course Title: Machine learning for Music Information Retrieval** **Type of Course: Discipline Elective in Signal processing basket Theory**	**L- P- C**	3	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	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 to familiarize the learners with the concepts of Machine learning for Music Information Retrieval and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 13) **Explain** the concept of signal processing and music theory. 14) **Discuss** and design different algorithms of MIR. 15) **Understand** various issues in music information retrieval. 16) **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	Toolbox for Music Information Retrieval	Assignment	System Design Task and Analysis	**10 Sessions**	

Topics:

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.

<table>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">Topics relevant to “EMPLOYABILITY SKILLS”: Chord detection, Music Retrieval Systems Extracting Information From Music Signal for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.</td></tr>
<tr><td>Catalogue prepared by</td><td>Dr.Azra Jeelani</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 15th, Dated BOS 28/07/2022</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Academic Council Meeting No. 18th, Dated 03/08/2022</td></tr>
</table>

Course Code: ECE3094	**Course Title: Video Processing and Computer Vision** **Type of Course: Open Elective**		**L-P-C**	3	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	**The objective of the course is to familiarize the learners with the concepts of Video Processing and Computer Vision and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques**				
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 Vision and Algorithms	Assignment	Programming Assignment	**12 session**	
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	Assignment	Programming Assignment	**12 session**	

	Vision			

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):

24. AL BOVIK, "Handbook of Image and Video Processing," Elsevier Science, 2nd Edition.
25. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011, 1st Edition.

Reference(s):
Reference Book(s):

12. Y. Wang, J. Ostermann, and Y. Q. Zhang, "Video Processing and Communications," 1st ed., Prentice Hall, 1st edition
13. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach," Prentice Hall; 1st edition
14. Richard Hartley, Andrew Zisserman, "Multiple View Geometry in Computer Vision," Cambridge University Press, 2 edition

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

15. Online notes :- https://web.eecs.umich.edu/~justincj/teaching/eecs442/WI2020/syllabus.html#
16. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc21_ee23/preview
17. Online ppts :- http://www.wu.ece.ufl.edu/courses/eee6512f16/index.htm
18. Online ppts:https://staff.fnwi.uva.nl/r.vandenboomgaard/IPCV20172018/20172018/syllabus.html
19. https://presiuniv.knimbus.com/user#/home

E-content:

66. 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
67. 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
68. 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
69. 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": Object detection and tracking various scenarios, Pattern Analysis, Face recognition and Tracking, Applications of computer vision in robotics and Autonomous Vehicles (ADAS) 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: 15th BOS held on 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No.18th , Dated 03/08/2022**

<table>
<tr><td>Course Code: ECE3095</td><td colspan="3">Course Title: Blockchain and Cryptocurrency Technologies
Type of Course: Open Elective</td><td>L-P-C</td><td>3</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">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of Blockchain and Cryptocurrency Technologies and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>INTRODUCTION TO BLOCKCHAIN</td><td colspan="3">Quiz</td><td>Memory Recall based Quizzes</td><td>08 sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 2</td><td>BLOCKCHAIN ARCHITECTURE</td><td colspan="3">Assignment / Quiz</td><td>Programming and Simulation task</td><td>10 sessions</td></tr>
<tr><td colspan="8">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)</td></tr>
<tr><td>Module 3</td><td>BLOCKCHAINS IN BUSINESSES</td><td colspan="3">Assignment</td><td>Analysis and Verification</td><td>12 sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
</table>

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):

26. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.

27. 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):

26. Andreas M. Antonopoulos , "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly Media Inc, 2015

27. 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.):

41. 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
42. 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
43. Prof. Gary Gensler's MIT OpenCourseWare on "Blockchain and Money": https://www.youtube.com/watch?v=EH6vE97qIP4
44. Simplilearn's Blockchain & Cryptocurrency Course for 2022: https://www.youtube.com/watch?v=-

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E-content:

70. 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
71. 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
72. 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
73. 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
74. 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
75. 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 relevant to "ENTREPRENEURIAL SKILLS": Blockchain, Bitcoin, Ethereum, Cryptocurrency mining for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Rajiv Ranjan Singh & Dr. Sreenivasappa B V
Recommended by the Board of Studies on	**BOS NO: 15th BOS held on 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18, Dated 03/08/2022**

Course Code: ECE3096	**Course Title: Natural Language Processing** **Type of Course: Open Elective** **Theory only**	**L- P-C**	3	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	**The objective of the course is to familiarize the learners with the concepts of Natural Language Processing and attain SKILL DEVELOPMENT through PARTICIPATIVE 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)** E**valuate the strengths and weaknesses of various NLP technologies and frameworks** **(3)** E**mploy 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 and Simulation task	**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
3. Spark NLP
4. IBM Watson
5. KILT
6. Apache OpenNLP
7. Cloud Natural Language | Google Cloud
8. Natural Language Processing – Amazon Comprehend – Amazon Web Services
9. NLTK :: Natural Language Toolkit
10. Stanford CoreNLP
11. TextBlob
12. spaCy
13. GenSim

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:

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

Topics relevant to "ENTREPRENEURIAL SKILLS": Information Retrieval: Design features of Information for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Rajiv Ranjan Singh Mr. Ramzan Basheer Ashwini B
Recommended by the Board of Studies on	BOS Meeting NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3097	**Course Title: Smart Electronics in Agriculture** **Type of Course:**	**L- P- C**	3	0	3
Version No.	2.0				
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 are 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.** **The associated assignment provides an opportunity to validate the concepts taught as well as enhances the ability to analyze the real-world problems in order to provide a solution using various simulation tools and hardware interfacing techniques.**				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Smart Electronics in Agriculture and attain ENTREPRENEURSHIP SKILLS through PARTICPATIVE 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	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	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	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

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:-

3 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

4 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

5 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

6 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	Mrs. Renuka Bhagwat
Recommended by the Board of Studies on	**15th BOS held on28/07/2022**
Date of Approval by the Academic Council	**Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE3098	**Course Title: Environment Monitoring system** **Type of Course: Theory**	**L- P- C**	3	0	3
Version No.	2.0				
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 to familiarize the learners with the concepts of **Environment Monitoring system** and attain **ENTREPRENEURSHIP SKILLS** through **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 / Quiz	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 Simulation task.	**09 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.

Textbook(s):

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.htciitm.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 " ENTREPRENEURSHIP SKILL": System design for environmental monitoring systems.	
Catalogue prepared by	Dr. Divya Rani
Recommended by the Board of Studies on	**15th BOS held on28/07/2022**
Date of Approval by the Academic Council	**Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE3099	**Course Title: Modern Wireless Communication with 5G** **Type of Course: Open Elective**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Modern Wireless Communication with 5G** and attain **ENTREPRENEURSHIP SKILLS** through **PARTICIPATIVE LEARNING techniques.**				
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

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.): Book Free Download (studymaterialz.in)

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	Mrs. Varalakshmi K R
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3100	**Course Title: Underwater Communication** **Type of Course: Open Elective**		**L- P- C**	3	0	3
Version No.	2.0				
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 to familiarize the learners with the concepts of Underwater Communication and attain ENTREPRENEURSHIP SKILLS through PARTICIPATIVE LEARNING techniques.				
Course Outcomes	**On successful completion of this course the students shall be able to:** 5. Discuss the concepts of sound waves 6. Design underwater signal processing systems 7. Analyze the performance of underwater signal processing systems 8. 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

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	Mrs. Varalakshmi K R
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3101	**Course Title:** Printed Circuit Board Design **Type of Course: Program Core Theory**		**L-P-C**	3	0	3
Version No.	2.0					
Course Pre-requisites	Basic electronics concept					
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	The objective of the course is to familiarize the learners with the concepts of Printed Circuit Board Design and attain **ENTREPRENEURSHIP** SKILLS through PARTICIPATIVE LEARNING **techniques**.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 14. Understand basics of PCB designing. 15. Apply advance techniques, skills and modern tools for designing and fabrication of PCBs. 16. Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB. 17. 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 studies		**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.

Text book:

28. 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 *4th International* 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3102	**Course Title: Consumer Electronics** **Type of Course: Open Elective**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Consumer Electronics** and attain ENTREPRENEURSHIP SKILLS by using PARTICIPATIVE LEARNING techniques.				
Course Outcomes	**On successful completion of this course the students shall be able to:** 9. Identify the devices and system functions 10. Classify the components in electronics 11. 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					
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 edition.

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:

4. 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.
5. 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
6. 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	Mrs. Varalakshmi K R
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3102	**Course Title: Consumer Electronics** **Type of Course: Open Elective**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Consumer Electronics** and attain ENTREPRENEURSHIP SKILLS by using PARTICIPATIVE LEARNING techniques.				
Course Outcomes	**On successful completion of this course the students shall be able to:** 12. Identify the devices and system functions 13. Classify the components in electronics 14. 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					
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 edition.

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:

7. 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.
8. 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
9. 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	Mrs. Varalakshmi K R
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3103	**Course Title: Product Design of Electronic Equipment** **Type of Course: Open Elective** **Theory only**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Product Design of Electronic Equipment** and attain ENTREPRENEURSHIP SKILLS through PARTICIPATIVE LEARNING.				
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**	Assignment	Mock up Design and Analysis Tasks	**10 Classes**	

	for Electronic Products			
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 Reliability**	Assignment	System Design Analysis	**07 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				
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.):** 45. 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 46. 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 47. 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 48. Prof. P. C. Pande's Lecture Notes on PCB Design (IIT Bmbay): https://www.ee.iitb.ac.in/~pcpandey/courses/ee616/pcblayout_c_aug07.pdf **E-content:** 76. 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 77. 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 78. 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 79. 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 80. Creusen, Marielle EH, and Jan PL Schoormans. "The different roles of product appearance in consumer choice." *Journal of product innovation management* 22, no. 1 (2005): 63-81. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.0737-6782.2005.00103.x 81. Archambeault, Bruce, Colin Brench, and Sam Connor. "Review of printed-circuit-board level EMI/EMC issues and tools." *IEEE Transactions on Electromagnetic compatibility* 52, no. 2 (2010): 455-461. https://ieeexplore.ieee.org/document/5466556				

82. Eshkeiti, Ali, Avuthu SG Reddy, Sepehr Emamian, Binu B. Narakathu, Michael Joyce, Margaret Joyce, Paul D. Fleming, Bradley J. Bazuin, and Massood Z. Atashbar. "Screen printing of multilayered hybrid printed circuit boards on different substrates." *IEEE transactions on components, packaging and manufacturing technology* 5, no. 3 (2015): 415-421. https://ieeexplore.ieee.org/document/7027841

Topics relevant to development of " ENTREPRENEURSHIP ": 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3104	**Course Title:Vehicle To Vehicle Communication** **Type of Course: Open Elective** **Theory**		**L- P- C**	3	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. **Communicat**e 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	**15th BOS held on28/07/2022**
Date of Approval by the Academic Council	**Meeting No. 18th, Dated 03/08/2022**

Course Code: **ECE3105**	**Course Title: Wavelets and Filter Banks (Open Elective)** **Type of Course:** **Theory Only**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Wavelets and Filter Banks** and attain **EMPLOYABILITY SKILLS** through **PARTICIPATIVE LEARNING.**				
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 perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision). 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. 5. Research, present, and report a selected project within a specified time. 6. Think critically, ask questions, and apply problem-solving techniques.				
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		Theoretical Understanding		**10**

		Assignment		**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	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

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.
7. M. Vetterli and D. L. Gall, "Perfect Reconstruction FIR Filter Banks: Some Properties and Factorizations," *IEEE Trans. Acoust., Speech, Signal Processing,* vol. 37, no. 7, pp. 1057-1071, July 1989.
8. M. Vetterli, "A Theory of Multirate Filter Banks," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. ASSP-35, no. 3, pp. 356-372, March 1987.
9. M. Vetterli and C. Herley, "Wavelets and Filter Banks: Theory and Design," *IEEE Trans. Signal Processing*, vol. 40, no. 9, pp. 2207-2232, September 1987.

More papers can be found in *http://ieeexplore.ieee.org/Xplore/dynhome.jsp*.

Catalogue prepared by	Ms. Swetha G
Recommended by the Board of Studies on	**15th BOS held on28/07/2022**
Date of Approval by the Academic Council	**Meeting No. 18th, Dated 03/08/2022**

Course Code: **ECE 3106**	**Course Title: Introduction to Data Analytics** **Type of Course: Open Elective Theory**		**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of **Introduction to Data Analytics** and attain **ENTREPRENEURIAL SKILLS SKILLS** through **Problem Solving 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	Assignments	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	Assignments	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	Assignments	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	Assignments	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)

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

Other Resources:

Presidency University Library Link

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

1. Big social data analytics of changes in consumer behaviour and opinion of a TV broadcaster | IEEE Conference Publication | IEEE Xplore

2. Forecasting Nike's sales using Facebook data | IEEE Conference Publication | IEEE Xplore

Topics relevant to development of "FOUNDATION SKILLS": Interpret the type of data analysis tools and techniques.

Topics relevant to "ENTREPRENEURIAL SKILLS ": Concepts of Data collection and analysis for an assignment.

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	**15th BOS held on28/07/2022**
Date of Approval by the Academic Council	**Meeting No. 18th, Dated 03/08/2022**

Course Code: ECE3107	**Course Title :** Machine Vision for Robotics **Type of Course:** **Open Elective Theory**	**L- P- C**	3	0	3
Version No.	2.0				
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	The objective of the course is to familiarize the learners with the concepts of Machine Vision for Robotics and attain **EMPLOYABILITY SKILLS** through **PARTICIPATIVE LEARNING.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 4) Explore various vision systems for Machines 5) Understand the image capturing and processing techniques 6) Apply the robotic operating system to Machines				
Course Content:					
Module 1	**Overview of Machine Vision in IP**	Group 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**	Presentation			**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**	Mini group Project			**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):

6. Carsten Steger, Markus Ulrich, Christian Wiedemann, **"Machine Vision Algorithms and Applications"**, WILEY-VCH, Weinheim,2008.
7. Damian m Lyons, **"Cluster Computing for Robotics and Computer Vision",** World Scientific, Singapore, 2011.

References:

Reference Book

4. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition - Wesley Publishing Company, New Delhi, 2007.
5. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
6. 3. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.
7. 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	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022