PRESIDENCY UNIVERSITY

Private University Estd. in Karnataka State by Act No. 41 of 2013

Itgalpura, Rajankunte, Yelahanka, Bengaluru – 560064

PRESIDENCY SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Program Regulations and Curriculum

2025-2029

BACHELOR OF TECHNOLOGY (B.Tech.) in

VLSI DESIGN TECHNOLOGY

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

Regulations No.: PU/AC-26.12/ECE21/EVL/2025-29

Resolution No. 12 of the 26th Meeting of the Academic Council held on 25th July, 2025, and ratified by the Board of Management in its 27th Meeting held on 28th July, 2025.

July-2025

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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 leader in education and research in Electronics and Communication Engineering domains by developing ethical, innovative and globally competent professionals committed to societal well-being.

1.6 Mission of Department of Electronics and Communication Engineering

- M1: Achieve Academic and professional excellence in Electronics and Communication Engineering that equip students with strong technical foundations, and globally-relevant skills.
- M2: Promote cutting-edge research, innovation and industry collaboration for knowledge transfer, technological support, entrepreneurship, and nation-building initiatives.

- M3: Engage in life-long learning to solve real-world problems with ethical, environmental and societal considerations.

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 2025-2029.
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 2025-2029 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 2025-2026.

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, 2025-2029;*

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 2025-2029 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 2025-2029 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. Succeed as VLSI Design Engineers with integrity and strong ethical values.

PEO2. Become competent professionals in VLSI domain and related fields in both industry and research.

PEO3. Engage in lifelong learning to adapt state of the art technologies and societal needs.

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 knowledge of mathematics, natural science,

computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems**.**

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development**.**

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required**.**

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions**.**

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems**.**

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment**.**

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws**.**

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams**.**

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments**.**

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking 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: Demonstrate expertise in the design, simulation, implementation, and analysis of complex problems in both analog and digital VLSI systems.

PSO2: Develop solutions to VLSI circuit problems using EDA tools, supported by research-driven investigation of trade-off parameters

PSO3: Plan, design, and execute projects in VLSI domain through collaboration with industries and higher learning institutions

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, 2025-2029, 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 (2025-2029) 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) 2025-2029: 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)	10
2	Basic Science Courses (BSC)	24
3	Engineering Science Courses (ESC)	22
4	Professional Core Courses (PCC)	64
5	Professional Elective Courses (PEC)	18
6	Open Elective Courses (OEC)	6
7	Project Work (PRW)	16
8	Mandatory Courses (MAC)	0
	Total Credits	**160**

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

Table 3.1 : List of Humanities and Social Sciences including Management Courses (HSMC)						
S.No	Course Code	Course Name	L	T	P	C
1	ENG1900	English for Technical Communication	2	0	0	2
2	ENG2501	Advanced English	2	0	0	2
3	APT4005	Aptitude for Employability	0	0	2	1
4	PPS3018	Preparedness for Interview	0	0	2	1
5	DES1146	Introduction to Design Thinking	1	0	0	1
6	FIN1002	Essentials of Finance	3	0	0	3
		Total No. of Credits				10

Table 3.2 : List of Basic Science Courses **(BSC)**						
S.No	Course Code	Course Name	L	T	P	C
1	MAT2301	Calculus and Differential Equations	3	1	0	4
2	MAT2302	Transform Techniques, Partial Differential Equations and Complex Variables	3	1	0	4
3	MAT2303	Linear Algebra and Vector Calculus	3	1	0	4
4	MAT2304	Numerical Methods, Probability Distributions and Sampling Techniques	3	1	0	4
5	PHY2502	Advanced Materials and Quantum Physics for Engineers	3	0	0	3
6	PHY2505	Advanced Materials and Quantum Physics for Engineers Lab	0	0	2	1
7	CHE2503	Applied Chemistry for Engineers	3	0	0	3
8	CHE2504	Applied Chemistry for Engineers Lab	0	0	2	1
		Total No. of Credits				24

Table 3.3 : List of Engineering Science Courses (ESC)						
S.No	Course Code	Course Name	L	T	P	C
1	CIV1200	Foundations of Integrated Engineering	2	0	0	2
2	MEC1006	Engineering Graphics	2	0	0	2
3	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3
4	EEE1250	Basics of Electrical and Electronics Engineering Lab	0	0	2	1
5	ECE1511	Design Workshop	1	0	2	2
6	CSE2280	C Programming and Data Structures	3	0	0	3
7	CSE2281	C Programming and Data Structures Lab	0	0	4	2
8	CSE2017	Essentials of AI	3	0	0	3
9	CSE2018	Essentials of AI Lab	0	0	2	1
10	CSE1500	Computational Thinking using Python	2	0	2	3
		Total No. of Credits				22

Table 3.4 : Professional Core Courses (PCC)						
S. No.	Course Code	Course Name	L	T	P	C
1	EEE2500	Network Theory	3	1	0	4
2	ECE2021	Digital Electronics	3	0	0	3
3	ECE2051	Digital Electronics Lab	0	0	2	1
4	ECE2508	Signal Processing	3	1	0	4
5	ECE2558	Signals Processing Lab	0	0	2	1
6	CSE2501	Computer Organization and Architecture	3	0	0	3
7	ECE2509	Solid State Electronics	3	0	0	3
8	ECE2510	Introduction to Fabrication Technology	3	0	0	3
9	ECE2560	Introduction to Fabrication Technology Lab	0	0	2	1
10	ECE2521	Embedded Systems Design using Microcontrollers	4	0	0	4
11	ECE2571	Embedded Systems Design using Microcontrollers Lab	0	0	2	1
12	ECE2512	Microelectronics	3	0	0	3
13	ECE2562	Microelectronics Lab	0	0	2	1
14	EEE2504	Control Systems	3	0	0	3
15	ECE2513	CMOS VLSI Design	3	0	0	3
16	ECE2563	CMOS VLSI Design Lab	0	0	2	1
17	ECE2514	Design for Testability	3	0	0	3
18	ECE2515	Mixed Signal Circuit Design	3	0	0	3
19	ECE2516	VLSI Design Verification	3	0	0	3
20	ECE2566	VLSI Design Verification Lab	0	0	2	1
21	ECE2517	Communication Systems	3	0	0	3

22	ECE2567	Communication Systems Lab	0	0	2	1
23	ECE2519	Physical Design and Automation	3	0	0	3
24	ECE2569	Physical Design and Automation Lab	0	0	2	1
25	ECE2523	Digital VLSI Design	3	0	0	3
26	ECE2573	Digital VLSI Design Lab	0	0	2	1
27	ECE2528	RF and HF IC Design	3	0	0	3
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	CHE7601	Environmental Studies	2	0	0	0
2	LAW7601	Indian Constitution	0	0	0	0
3	CIV7601	Universal Human Values and Ethics	0	0	0	0
4	PPS1025	Industry Readiness Program - I	0	0	2	0
5	PPS1026	Industry Readiness Program - II	0	0	2	0
6	APT4002	Introduction to Aptitude	0	0	2	0
7	APT4004	Aptitude Training - Intermediate	0	0	2	0
8	APT4006	Logical and Critical Thinking	0	0	2	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
7	ECE3206	Object-Oriented Programming Essentials using JAVA	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

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
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	Advanced VLSI and SoC Design	3	0	0	3
7	ECE3461	VLSI Algorithms and Design	3	0	0	3
8	ECE3462	Low Power VSI 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
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

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
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	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	3	0	0	3
7	ECE3445	Internet of Medical Things	3	0	0	3
8	ECE3446	Internet of Agricultural Things	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.

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
Chemistry Basket							
1	CHE3001	Smart Materials and 3D Printing	3	0	0	3	-
2	CHE3002	Enenrgy and Sustainability	3	0	0	3	-

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
3	CHE3003	Nano technology and its applications	3	0	0	3	-
4	CHE3004	Corrosion and control	3	0	0	3	-
5	CHE3005	Green Chemistry and Susstainable Technology	3	0	0	3	-
6	CHE3006	Food Technology	3	0	0	3	-
Civil Engineering Basket							
1	CIV3100	Disaster mitigation and management	3	0	0	3	-
2	CIV3101	Sustainability Concepts in Engineering	3	0	0	3	-
3	CIV3102	Occupational Health and Safety	3	0	0	3	-
4	CIV3103	Sustainable Materials and Green Buildings	3	0	0	3	-
5	CIV3104	Integrated Project Management	3	0	0	3	-
6	CIV3105	Environmental Impact Assessment	3	0	0	3	-
7	CIV3106	Infrastructure Systems for Smart Cities	3	0	0	3	-
8	CIV3107	Geospatial Applications for Engineers	3	0	0	3	-
9	CIV3108	Environmental Meteorology	2	0	2	3	-
10	CIV3109	Project Problem Based Learning	3	0	0	3	-
11	CIV3110	Sustainability for Professional Practice	3	0	0	3	-
Commerce Basket							
1	MGT2015	Engineering Economics	3	0	0	3	-
2	MGT2020	Marketing Fundamentals for Engineers	3	0	0	3	-
3	MGT2021	Finance for Engineers	3	0	0	3	-
4	MGT2007	Digital Entreprenuership	3	0	0	3	-
5	COM1020	Business Accounting & Financial Analysis	2	1	0	3	-
6	BBA2088	Management and Behavioural Practices	3	0	0	3	-
Design Basket							
1	DES2001	Design Thinking	3	0	0	3	-
Electrical and Electronics Basket							
1	EEE3100	IoT based Smart Building Technology	3	0	0	3	-
2	EEE3101	Basic Circuit Analysis	3	0	0	3	-
3	EEE3102	Fundamentals of Industrial Automation	3	0	0	3	-
4	EEE3103	Electric Vehicles & Battery technology	3	0	0	3	-
5	EEE3104	Smart Sensors for Engineering Applications	3	0	0	3	-
Electronics and Communication Engineering 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							

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
1	ENG1906	Law and Crime in Popular Imagination	3	0	0	3	
2	ENG1909	Exploring Gender: Narratives from Campus to Community	2	0	2	3	
3	ENG1910	Trauma Narratives: From Page to Pixel	3	0	0	3	
4	ENG1911	'Nonsense' Across Media	3	0	0	3	
5	ENG1912	Language and Interpretation	2	0	2	3	
Law Basket							
1	LAW2015	Cyber Law	3	0	0	3	-
2	LAW5005	Law relating to Infrastructure Projects	3	0	0	3	
Mathematics Basket							
1	MAT3030	Optimization Techniques for Engineers	3	0	0	3	-
2	MAT3031	Basic Statistics & Data Analysis	3	0	0	3	-
3	MAT3032	Mathematics for Machine Learning	3	0	0	3	-
4	MAT3033	Bioinformatics & Computational Biology	3	0	0	3	-
5	MAT3034	Time-Frequency Transforms for Signal Analysis	3	0	0	3	-
6	MAT3035	Mathematical Modeling	3	0	0	3	-
7	MAT3036	Bio-Statistics and Bio-Modelling	3	0	0	3	-
8	MAT3037	Linear Algebra & Matrix Theory	3	0	0	3	-
9	MAT3038	Financial Mathematics	3	0	0	3	-
10	MAT3039	Fuzzy Logic & Neural Networks	3	0	0	3	-
11	MAT3040	Discrete Mathematics	3	0	0	3	-
Media Studies Basket							
1	BAJ3006	Brand Management	3	0	0	3	-
2	BAJ3007	Communication for Social Impact	3	0	0	3	-
3	BAJ3035	Business Journalism	3	0	0	3	-
4	BAJ3017	Political Communication	3	0	0	3	-
5	BAJ3042	Media Literacy Education	3	0	0	3	-
Mechanical Basket							
1	MEC3250	Engineering Drawing	3	0	0	3	-
2	MEC3251	Supply Chain Management	3	0	0	3	-
3	MEC3252	Six Sigma for Professionals	1	0	4	3	-
4	MEC3253	Fundamentals of Aerospace Engineering	3	0	0	3	-
5	MEC3254	Safety Engineering	3	0	0	3	-
6	MEC3255	Additive Manufacturing	3	0	0	3	-
7	MEC3256	Sustainable Technologies and Practices	3	0	0	3	-
8	MEC3257	Industry 4.0	3	0	0	3	-
Petroleum Basket							
1	PET3301	Energy Industry Dynamics	3	0	0	3	-
2	PET3302	Energy Sustainability Practices	3	0	0	3	-
Management Basket – I (One Course to be opted as part of HSMC Basket)							
1	MGTXXXX	Managerial Economics and Finance	3	0	0	3	-

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
2	MGT2004	Development of Enterprises	3	0	0	3	-
3	MGT2010	Managing People and Performance	3	0	0	3	-
4	MGT2020	Marketing for Engineers	3	0	0	3	-

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 (Chemistry Cycle)										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE						TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS	BASKET		
1	MAT2301	Calculus and Differential Equations	3	1	0	4	4	BSC		
2	CIV1200	Foundations of Integrated Engineering	2	0	0	2	2	ESC		
3	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3	3	ESC		
4	EEE1250	Basics of Electrical and Electronics Engineering Lab	0	0	2	1	2	ESC		
5	CHE2503	Applied Chemistry for Engineers	3	0	0	3	3	BSC		
6	CHE2504	Applied Chemistry for Engineers Lab	0	0	2	1	2	BSC		
7	CSE1500	Computational Thinking using Python	2	0	2	3	4	ESC		
8	ENG1900	English for Technical Communication	2	0	0	2	2	HSMC		
9	LAW7601	Indian Constitution	0	0	0	0	0	MAC		
10	PPS1025	Industry Readiness Program – I	0	0	2	0	2	MAC		
		TOTAL				19	24	-	-	-

Semester 2 (Physics Cycle)										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	MAT2302	Linear Algebra and Vector Calculus	3	1	0	4	4	BSC		
2	MEC1006	Engineering Graphics	2	0	0	2	2	ESC		
3	PHY2502	Advanced Materials and Quantum Physics for Engineers	3	0	0	3	3	BSC		

4	PHY2505	Advanced Materials and Quantum Physics for Engineers Lab	0	0	2	1	2	BSC		
5	ECE2021	Digital Electronics	3	0	0	3	3	PCC		
6	ECE2051	Digital Electronics Lab	0	0	2	1	2	PCC		
7	DES1146	Introduction to Design Thinking	1	0	0	1	1	HSMC		
8	ENG2501	Advanced English	2	0	0	2	2	HSMC		
9	ECE1511	Design Workshop	1	0	2	2	3	ESC		
10	CHE7601	Environmental Studies	2	0	0	0	2	MAC		
11	PPS1026	Industry Readiness Program – II	0	0	2	0	2	MAC		
		TOTAL				19	26			

Semester 3										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	MAT2503	Transform Techniques, Partial Differential Equations and Probability	3	1	0	4	4	BSC		
2	EEE2500	Network Theory	3	1	0	4	4	PCC		
3	ECE2508	Signal Processing	3	1	0	4	4	PCC		
4	ECE2558	Signals Processing Lab	0	0	2	1	2	PCC		
5	ECE2517	Communication Systems	3	0	0	3	3	PCC		
6	ECE2567	Communication Systems Lab	0	0	2	1	2	PCC		
7	FIN1002	Essentials of Finance	3	0	0	3	3	HSMC		
8	CSE2280	C Programming and Data Structures	3	0	0	3	3	ESC		
9	CSE2281	C Programming and Data Structures Lab	0	0	2	1	2	ESC		
10	CIV7601	Universal Human Values and Ethics	0	0	0	0	0	MAC		

		TOTAL				24	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	1	0	4	4	BSC		
2	ECE2509	Solid State Electronics	3	0	0	3	3	PCC		
3	ECE2512	Microelectronics	3	0	0	3	3	PCC		
4	ECE2562	Microelectronics Lab	0	0	2	1	2	PCC		
5	ECE2510	Introduction to Fabrication Technology	3	0	0	3	3	PCC		
6	ECE2560	Introduction to Fabrication Technology Lab	0	0	2	1	2	PCC		
7	EEE2504	Control Systems	3	0	0	3	3	PCC		
8	ECE2521	Embedded Systems Design using Microcontrollers	4	0	0	4	4	PCC		
9	ECE2571	Embedded Systems Design using Microcontrollers Lab	0	0	2	1	2	PCC		
10	APT4004	Aptitude Training - Intermediate	0	0	2	0	2	MAC		
		TOTAL				23	26			

Semester 5										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	T	P	C	CONTACT HOURS			
1	ECE2514	Design for Testability	3	0	0	3	3	PCC		
2	CSE2501	Computer Organization and Architecture	3	0	0	3	3	PCC		
3	ECE2522	CMOS VLSI Design	3	0	0	3	3	PCC		
4	ECE2572	CMOS VLSI Design Lab	0	0	2	1	2	PCC		
5	CSE1700	Essentials of AI	3	0	0	3	3	ESC		
6	ECEXXXX	Professional Elective - I	3	0	0	3	3	PEC		
7	ECEXXXX	Professional Elective - II	3	0	0	3	3	PEC		

8	CSE1701	Essentials of AI Lab	0	0	4	2	4	ESC		
9	PPS4006	Logical and Critical Thinking	0	0	2	0	2	HSMC		
		TOTAL				21	26			

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		
2	ECE2523	Digital VLSI Design	3	0	0	3	3	PCC		
3	ECE2573	Digital VLSI Design Lab	0	0	2	1	2	PCC		
5	ECE2516	VLSI Design Verification	3	0	0	3	3	PCC		
6	ECE2566	VLSI Design Verification Lab	0	0	2	1	3	PCC		
7	ECEXXXX	Professional Elective - III	3	0	0	3	3	PEC		
8	ECEXXXX	Professional Elective - IV	3	0	0	3	3	PEC		
9	XXXXXXX	Open Elective - I	3	0	0	3	3	OEC		
10	ECE7100	Minor Project	-	-	-	4	-	PRW		
		TOTAL				25	25			

Semester 7										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	T	P	C	CONTACT HOURS			
1	ECE2519	Physical Design and Automation	3	0	0	3	3	PCC		
2	ECE2569	Physical Design and Automation Lab	0	0	2	1	3	PCC		
3	ECE2528	RF and HF IC Design	3	0	0	3	3	PCC		
4	ECEXXXX	Professional Elective - V	3	0	0	3	3	PEC		
5	ECEXXXX	Professional Elective - VI	3	0	0	3	3	PEC		
6	XXXXXXX	Open Elective - II	3	0	0	3	3	OEC		
7	ECE7000	Internship	-	-	-	2	-	PRW		

8	PPS3018	Preparedness for Interview	0	0	2	1	2	HSMC		
		TOTAL				18	18			

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	0	EM	
		TOTAL				10	-			

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.

HSMC Basket

Course code: ENG1900	Course Title: English for Technical Communication School core and Theory Only	L- T- P- C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	+2 Level					
Anti-requisites	NIL					
Course Description	This course enhances the technical communication skills of BTech students, focusing on clarity, precision, and conciseness in academic and professional settings. Students will learn to differentiate between general and technical communication, analyze technical content, develop structured writing skills, and deliver effective presentations. Through interactive activities such as TED Talk analyses, report writing, and presentation practice, the course provides hands-on experience for real-world applications. By the end, students will be equipped to communicate complex technical information effectively in various professional contexts.					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Differentiate between general and technical communication. 2. Explain key reading comprehension techniques to enhance understanding of technical texts. 3. Write clear, concise, and well-structured technical reports and documents. 4. Deliver technical presentations and implement peer feedback for continuous improvement. 5. Explain ethical practices in digital communication for professional use.					

Course Content: Theory				
Module 1	Technical communication	Quiz	Listening	9 Hours
Introduction to Communication, Technical vs. General Communication, Characteristics of technical communication, Importance of clarity, precision, and objectivity Activity: Watching TED Talks/videos to identify differences in technical and general vocabulary				
Module 2	Technical Reading	Assignment	Reading	12 Hours
Reading Comprehension, Note making & Note taking, Content Analysis Activity: Reading technical articles and answering comprehension questions Note making techniques				
Module 3	Technical Writing	Assignment	Writing	12hours
Paragraph Writing, Structure of a paragraph (topic sentence, supporting details, coherence) Report Writing, Structure of technical and project reports (Introduction, Methods, Results, Discussion) Activity: Writing a structured paragraph on a technical topic Writing project reports				

Module 4	Professional Presentation	Presentation	Speaking	12Hours
Introduction to Presentation Skills, Preparing a Presentation, Structuring content (Introduction, Body, Conclusion), Designing effective slides (Text. visual aids, readability, and impact) Delivering a Presentation, Engagement techniques, Storytelling, narration, pitching ideas handling Q&A Conviction, commitment, generating interest through enthusiasm Demonstration & Practice:-Giving presentations on topics based on their academic interest , Evaluating and providing peer feedback Activity: Analyze a real-world engineering issue and present solutions using a structured approach.				
Targeted Application & Tools that can be used: YouTube, Instagram, Quill Bot, Grammarly, & Padlet.				
References: Text books: 1. Gupta, R.C. *Technical Communication.* 2nd ed., Cambridge University Press, 2021. 2. Lannon, John M., and Laura J. Gurak. *Technical Communication.* 15th ed., Pearson, 2022. Reference Books: 1. Gerson, Sharon J., and Steven M. Gerson. Technical Communication: Process and Product. 9th ed., Pearson, 2020. 2. Lannon, John M., and Laura J. Gurak. Technical Communication. 15th ed., Pearson, 2022. 3. Markel, Mike, and Stuart A. Selber. Technical Communication. 13th ed., Bedford/St. Martin's, 2020. Web Resources: 1. https://owl.purdue.edu/owl/subject_specific_writing/technical_writing. 2. https://journals.ieeeauthorcenter.ieee.org/. 3. https://www.stc.org/. 4. https://ocw.mit.edu/.https://www.ted.com/talks.				
Topics Relevant to "employability": Teamwork and Collaboration, Critical Thinking and Problem-Solving Topics Relevant to "Human Values and Professional Ethics": Critical reasoning, Inclusivity and Fairness				

Catalogue prepared by	Dr. Vinodhini Chinnaswamy & Dr. T. Naresh Naidu
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: PPS 018	Course Title: Preparedness for Interview Type of Course: Practical Only Course	L- T- P- C	0	0	2	1
Version No.		1.0				
Course Pre-requisites		Students are expected to understand Basic English. Students should have desire and enthusiasm to involve, participate and learn.				
Anti-requisites		NIL				
Course Description		This course is designed to enable students to understand soft skills concepts to be corporate ready. The modules are set to improve self-confidence, communicate effectively and Prepare for the Interview to assist in employability. It helps the students to get a glimpse of the acceptable corporate readiness and equip them with the fundamental necessities of being able to confidently deal with the highly competitive corporate environment and helps in crafting different types of resumes. The pedagogy used will be group discussions, flipped classrooms, continuous feedback, role-play and mentoring.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of				
Course Out Comes		On successful completion of this course the students shall be able to: CO1: Develop professional Resumes CO2: Illustrate Resumes effectively CO3: Apply skills and knowledge learnt for active and effective Group Discussions and Interview				
Course Content:						
Module 1	Resume Building	Classroom activity		10 Hours		
	Topics: Resume structure, use of templates, Do's and Don'ts, ATS methods, Cover Letter and Video Resume Activity: Real world scenarios					

Module 2	Group Discussion	Mock G D		9 Hours
	Topics: -Group discussion as a placement process, GD techniques like Keyword. SPELT & POV o affected parties. Do & Don't of GD, Case-lets and topics for GD, practice session and evaluation Activity:- Real world scenarios			
Module 3	Personal Interview	Grooming checks + Evaluation + Mock Interview+ Role Play		9 Hours
	Topics: Placement process, Different interview rounds, HR interviews, Interview questions and desired answers, Different types of interviews, Do's and Don'ts. Activity: - Role Play & Real-world scenario			
Module 4	Recap/Revision /Feedback Session	Practice sessions		2 Hours
	Targeted Application & Tools that can be used: 1. TED Talks 2. You Tube Links 3. Role Play activities			
	Project work/Assignment: Mention the Type of Project /Assignment proposed for this course			
	Continuous Individual Assessment			
	The Topics related to Skill Development: Art Of Presentation and Group Discussion for Skill Development through Participative Learning Tech- niques. This is attained through assessment Component mentioned in course handout.			
Catalogue prepared by		Faculty of L&D		
Recommended by the Board of Studies on		BOS held on		
Date of Approval by the Academic Council		Academic Council Meeting held on		

Course Code: APT4005	Course Title: Aptitude For Employability Type of Course: Practical Only	L- T-P-C	0	0	2	1

Version No.		1.0
Course Pre-requisites		Students should have the basic concepts of Quantitative aptitude, Verbal ability along with its applications in real life problems.
Anti-requisites		Nil
Course Description		This course is designed to enable the students to enhance their skills in quantitative aptitude and verbal ability skills.
Course Objective		The objective of the course is to familiarize the learners with concepts in Quantitative Aptitude and Verbal ability through problem solving techniques suitable for their career development.
Course Outcomes		On successful completion of the course the students shall be able to: CO1] Recall all the basic mathematical concepts CO2] Identify the principle concept needed in a question CO3] Solve the quantitative and logical ability questions with the appropriate concept.
Course Content:		

Module 1	Quantitative Ability	Lab-10hrs		Platform Assessment-10hrs	20 Hours
	Topics: Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss, Time Speed and Distance, Simple Interest and Compound Interest, Probability, Permutation and Combination.				
Module 2	Verbal Ability	Lab-5hrs		Platform Assessment-5hrs	10 Hours
	Topics: - Parts of Speech, Subject Verb Agreement, Spotting Error, Cloze Test, Verbal Analogies, Reading Comprehension, Idioms & Phrases, Para Jumbles				
	Targeted Application & Tools that can be used: Application area: Placement activities and Competitive examinations. Tools: LMS				
Evaluation	Continuous Evaluation • Topic wise evaluation				
	Text Book 1. Fast track objective by Rajesh Verma 2. R S Aggarwal 3. S.P Bakshi				

References 1. www.indiabix.com 2. www.testbook.com 3. www.youtube.com/c/TheAptitudeGuy/videos	
Topics relevant to Skill development: Quantitative and reasoning aptitude for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Faculty of L&D
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code:
FIN1002</td><td colspan="3">Course Title: Essentials of Finance
Type of Course: HSMC</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">This course is designed to be accessible to all students, regardless of their prior financial knowledge.</td></tr>
<tr><td>Anti-requisites</td><td colspan="8"></td></tr>
<tr><td>Course Description</td><td colspan="8">This course is designed to equip students with a foundational understanding of key financial concepts and principles. It will enable them to comprehend the core functions of finance, delve into the intricacies of financial management within organizations, and gain insights into the fundamental aspects of taxation. The course aims to develop students' abilities to interpret financial statements, evaluate investment opportunities, understand capital structure decisions, and navigate the basics of tax implications.</td></tr>
<tr><td>Course Objective</td><td colspan="8">Upon successful completion of this course, students will be able to:
• Understand the basic forms of business organization and their financial implications.
• Understand the fundamental principles and concepts that influence financial decision-making in various contexts.
• Analyse and interpret financial statements to assess the financial health and performance of an organization.
• Identify income under various heads of income as per Income Tax Act, 1961 and determine the tax liability.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">List the course outcomes
On successful completion of this course the students shall be able to:
1. Understand the basic concepts of finance and financial markets and organizations.
2. Apply and interpret financial information for business decision making.
3. Identify various heads of income and deduction under Income Tax Act, 1961.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Finance</td><td colspan="2">Assignment/ Quiz</td><td colspan="2">Numerical solving Task</td><td colspan="2">10 Sessions</td></tr>
<tr><td colspan="9">Definition and Scope of Finance, Areas of Finance: Corporate Finance, Investments, Financial Institutions, International Finance; Types of Financial Markets: Money Markets vs. Capital Markets, Primary vs. Secondary Markets; Forms of Business Organization and Financial Goals: Shareholder Wealth Maximization vs. Profit Maximization; Understanding Financial Statements: Balance Sheet and Income Statement- Simple Numerical.</td></tr>
<tr><td>Module 2</td><td colspan="2">Financial Management</td><td colspan="2">Assignment/ Quiz</td><td colspan="2">Numerical solving Task</td><td colspan="2">18 Sessions</td></tr>
<tr><td colspan="9">Capital Budgeting Decisions: Payback Period, Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR); Leverage- Basic Numerical; Capital Structure Decisions: Optimal Capital Structure, Trade-off Theory of Capital Structure; Cost of Capital: Equity, Debt, WACC; Dividend Policy: Factors influencing Dividend Policy.</td></tr>
<tr><td>Module 3</td><td colspan="2">Taxation</td><td colspan="2">Assignment/ Quiz</td><td colspan="2">Numerical solving Task</td><td colspan="2">17 Sessions</td></tr>
<tr><td colspan="9">Principles of a Good Tax System: Equity, Certainty, Convenience, Economy; Direct vs. Indirect Taxes; Residential Status of an Individual- Basic Problems; Heads of Income; Salary, House Property- Basic Numerical; Deductions under Chapter VI-A; Computation of Taxable Income and Tax Liability; E-Filing procedure.</td></tr>
<tr><td colspan="9">Targeted Application & Tools that can be used:
Textbooks, PPT, Spreadsheet Software (e.g., Microsoft Excel), Official Website of Income Tax Department.</td></tr>
<tr><td colspan="9">Project Work/ Assignment:</td></tr>
</table>

1. 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.

2. Case Study: - At the end of the course students will be given a 'real-world' cases like business models of successful companies or tax evasion by reputed companies on which they have to come up with detailed analysis and assessment.

Text Book(s):

1. Dr. Vinod K. Singhania & Dr. Monica Singhania. (Latest Assessment Year Edition). *Students' Guide to Income Tax including GST*. Taxmann Publications.
2. Pandey, I. M. (2025). *Financial Management*. Vikas Publishing House.

Reference Book (s):

1. Bhole, L.M., & Mahakud, J. (Current Edition). *Financial Institutions and Markets: Structure, Growth and Innovations*. McGraw Hill Education India.
2. Mehrotra, H.C., & Goyal, S.P. (Latest Assessment Year Edition). *Income Tax Law & Practice*. Sahitya Bhawan Publications.
3. Gordon, E., & Natarajan, K. (Current Edition). *Financial Markets and Services*. Himalaya Publishing House.

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

1. https://presidencyuniversity.linways.com
2. https://onlinecourses.nptel.ac.in/noc24_ec01/preview
3. https://www.incometax.gov.in/iec/foportal/

Topics relevant to "SKILL DEVELOPMENT": This course is designed to provide practical financial skills through participative learning techniques. Students will engage in performing suitable calculations to determine financial parameters (e.g., time value of money, investment returns, tax liabilities) and analysing financial statements to assess organizational performance and make informed decisions.

Catalogue prepared by	Dr. Amit Saha
Recommended by the Board of Studies on	BoS No: 6th BOS, 5 June 2025
Date of Approval by the Academic Council	26th Academic Council Meeting held on June 2025

BSC Basket

Course Code: MAT2301	Course Title: Calculus and Differential Equations Type of Course:1] School Core	L-T- P-C	3	1	0	4

Version No.		1.0
Course Pre-requisites		Basic Concepts of Limits, Differentiation, Integration (PU level)
Anti-requisites		NIL
Course Description		Calculus and differential equations are used ubiquitously throughout mathematics, statistics and operations research. In this course, students can be able to build upon the foundations of calculus established to greatly enhance their repertoire of theory and practice in these areas. The application of calculus and differential equations in the description and modelling of real-world problems will also be considered. This unit will extend the problem-solving skills, range of knowledge and use of techniques in differential and integral calculus. The course focuses on the concepts of Calculus and Differential Equations with reference to specific engineering problems. The course is of both conceptual and analytical type in nature.
Course Objective		The goal of the course Calculus and Differential Equations is to facilitate the students with a concrete foundation of differential calculus and to solve the first and higher-order ordinary differential equations enabling them to acquire the knowledge of these mathematical tools.
Course Out Comes		On successful completion of the course the students shall be able to: 1) Apply the knowledge of differential calculus to solve problems related to ordinary and partial derivatives. 2) Apply the principles of integral calculus to evaluate integrals. 3) Learn the notion of partial differentiation to calculate rate of change of multivariate functions and solve problems related to composite functions and Jacobian. 4) Solve first-order linear/nonlinear ordinary differential equations analytically using standard methods.
Course Content:		

Module 1	Calculus		(14 lectures)
Introduction, Application, Limit, continuity, Rolle's theorem, Mean value theorems, Indeterminate forms and L'Hospital's rule; Definite and indefinite integrals, Reduction formulae (without proof) of $\int \sin^n x\ dx$, $\int \cos^n x\ dx$ and $\int \sin^m x \cos^n x\ dx$ (m and n are positive integers), evaluation of these integral with standard limits (0 to $\frac{\pi}{2}$), Beta and Gamma functions and their properties.			
Module 2	Multivariable Calculus	Assignment	(8 lectures)
Partial derivatives, total derivative, Taylor's and Maclaurin (self-study) theorems, Euler's Theorem, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers (self-study);			
Module 3	Multiple integrals		(10 lectures)
Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Triple integrals (Cartesian); Applications: areas, volume - Center of mass and Gravity (constant and variable densities), orthogonal curvilinear			

coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds (self study);

Module 4	Differential Equations	Assignment	(14 lectures)

Introduction, types of differential equation–variable separable (self study), Homogeneous, Exact, linear, Bernoulli's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type; Linear differential equations of second and higher order with constant coefficients - non-homogeneous term of the type $Q(x) = e^{ax}$, Sin ax, Cosax, $e^{ax}v(x)$- Method of variation of parameters.

Targeted Application & Tools that can be used:
Differential calculus is used extensively in science and engineering. It can solve problems related to motion, velocity, acceleration, angles of incline or curve on a surface, etc. Differential Equations are used to model the behavior of electromagnetic fields, including in the design of antennas, microwave ovens, and other devices. Biology: DEs are used to model biological processes, such as the spread of diseases and the development of biological tissues.
Tools Used: Python.

Assignment:

Select any one simple differential equation pertaining to the respective branch of engineering, identify the dependent and independent variable – Obtain the solution and compare the solution sets by varying the values of the dependent variable.

Text Book

1. Erwin Kreyzig (2015), Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition
2. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.

References:

1. Victor Henner, Tatyana Belozerova, Mickhail Khenner, Ordinary and Partial Differential Equations, CRC Press, Edition, 2013.
2. Walter Ledermann, Multiple integrals, Springer, 1st edition
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

E-resources/ Web links:

1. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_103205
2. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_106839
3. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_61605
4. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_134719
5. https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html

Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of calculus and differential equation with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem solving. This is attained through the assessment component mentioned in course handout.

Catalogue prepared by		Dr. Jagan K& Dr. Meenakshi
Recommended by the Board of Studies on		14th BOS – Friday, 6th June 2025

Date of Approval by the Academic Council		

Course Code: MAT2302	Course Title: Transform Techniques, Partial Differential Equations and Complex Variables Type of Course:1] School Core	L-T- P-C	3	1	0	4

Version No.		1.0
Course Pre-requisites		MAT2301 & MAT2302
Anti-requisites		NIL
Course Description		This course aims to introduce various transform techniques such as Laplace transform, Fourier transform and Z-transform in addition to expressing functions in terms of Fourier series. The course covers applications of Laplace transform to LCR circuits and solutions of different equations using Z-transform. The course also deals with the analytical methods for solving partial differential equations and the classical applications of partial differential equations. Complex variables studies function where both the independent and dependent variables are complex numbers, exploring concepts like differentiation, integration, power series, contour integration, and singularities within the complex plane.
Course Objective		The objective of the course is to familiarize the learners with the concepts of "Transform Techniques, Partial Differential Equations and Complex Variables" and attain Skill Development through Problem Solving Techniques.
Course Out Comes		On successful completion of the course the students shall be able to: CO1 - Express functions in terms of uniformly convergent Fourier series. CO2 - Apply Laplace transform technique to solve differential equations. CO3 - Employ Z-transform techniques to solve difference equations. CO4 - Solve a variety of partial differential equations analytically.
Course Content:		

Module 1	Laplace Transforms		(8 Classes)
Definition and Laplace transforms of elementary functions. Properties of Laplace transform, and Laplace transform of periodic function, unit-step function and Impulse function – related problems. Inverse Laplace transform of standard functions - problems, initial and final value theorem. Convolution theorem, solution of linear and simultaneous differential equations and LCR Circuit.			
Module 2	Fourier Series		(6 Classes)
Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.			
Module 3	Fourier Transforms and Z - Transforms	Assignment	(9 Classes)
Fourier Transforms: Definitions, infinite Fourier transforms, Fourier sine and cosine			

transforms, inverse Fourier transforms, Problems.
Difference equations and Z-transforms: Z-transforms – Basic definitions, Standard Z-transforms, Linearity property, Damping rule, Shifting rule, Initial value theorem, Final value theorem, Inverse Z-transforms. Difference equations – Basic definitions, Application of Z-transforms to solve difference equations.

Module 4	Partial Differential Equations		(9 Classes)

Formation of PDE, Solution of non-homogeneous PDE by direct integration, Solution of homogeneous PDE involving derivative with respect to one independent variable only (Both types with given set of conditions) Method of separation of variables. (First and second order equations) Solution of Lagrange's linear PDE. of the type P p + Q q = R.
Applications of PDE: Derivation of one-dimensional wave and heat equations. Various possible solutions of these by the method of separation of variables. D'Alembert's solution of wave equation. Two-dimensional Laplace's equation – various possible solutions. Solution of all these equations with specified boundary conditions (Boundary value problems).

Module 5	Complex Variables	Assignment	(12 Classes)

Introduction, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; Conformal mappings.
Complex Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).

Targeted Application & Tools that can be used:
The objective of the course is to familiarize students with a variety of numerical techniques and the theoretical concepts of probability and statistics to equip them with the necessary numerical approaches and basic statistical tools to tackle engineering and real-life problems.

Assignment:

Newton-Raphson Methods, Gauss-Seidel Method, LU Decomposition, Trapezoidal Rule, Simpson's rule, Runge-Kutta 4th Order.

Text Book

1. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition
2. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.

References:

1. Victor Henner, Tatyana Belozerova, Mickhail Khenner, Ordinary and Partial Differential Equations, CRC Press, Edition, 2013.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering, Computations, 6th Edition, New age Publishing House, 2015.
3. Walter Ledermann, Multiple integrals, Springer, 1st edition.
4. C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics", 6th Ed, McGraw-Hill, 2012.

E-resources/ Web links:
https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_140238
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https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_246791
. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_223548
. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&u

nique_id=EBSCO95_30102024_134719 . https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_32614 . https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html . https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: This course aims to introduce various transform techniques such as Laplace transform, Fourier transform, and Z transform in addition to expressing functions in terms of Fourier series. The course covers applications of Laplace transform to LCR circuits and solution of difference equations using z-transform. The course also deals with the analytical methods for solving partial differential equations and the classical applications of partial differential equations. Overall, this course provides the knowledge of transform techniques and partial differential equations for Skill Development through Problem Solving methodologies. This is attained through assessment component.

Catalogue prepared by		Dr. Veeresh Sajjanar
Recommended by the Board of Studies on		14th BOS held on 06/06/2025
Date of Approval by the Academic Council		

Course Code: MAT2303	Course Title: Linear Algebra & Vector Calculus Type of Course:1] School Core	L-T- P-C	3	1	0	4

Version No.		1.0
Course Pre-requisites		MAT2301
Anti-requisites		NIL
Course Description		This course explores the fundamental concepts of vectors, matrices, and their operations within the context of calculus, including vector differentiation and integration, while applying these tools to solve problems related to linear systems, transformations, and geometric interpretations in higher dimensions, often with applications in fields like physics, engineering, and computer graphics; key topics include vector algebra, matrix operations, determinants, eigenvalues, eigenvectors, gradients, divergence, curl, line integrals, surface integrals, and the fundamental theorems of vector calculus like Green's Theorem, Stokes' Theorem, and the Divergence Theorem.
Course Objective		The course is intended to develop computational proficiency involving procedures in Matrices, Linear Algebra and Vector Calculus which are useful to all engineering disciplines. This course is to equip students with the ability to understand and manipulate vectors in multidimensional space, apply matrix operations to solve systems of linear equations, and utilize concepts like gradients, divergence, and curl to analyze physical phenomena, all while developing a strong foundation for applying these tools in various scientific and engineering fields like physics, mechanics, and computer graphics.
Course Out Comes		On successful completion of the course the students shall be able to: CO1 - Use matrix methods and certain techniques to solve the system of linear equations and to find eigen values, eigen vectors of a matrix to check whether it is diagonalizable. CO2 - Understand the abstract notions of vector space and dimensionality of it. CO3 - find the matrix representation of a linear transformation given bases of the relevant vector spaces. CO4 - Learn different notions of vector and scalar fields with their properties. Understanding the major theorems (Green's, Stokes', Gauss') and some applications of these theorems.
Course Content:		

Module 1	Systems of Linear Equations		*(6 Classes)*
Systems of Linear Equations, Matrices and Elementary Row Operations, Echelon forms, Matrix operations, invertible matrices, Determinants and their properties, Cramer's Rule, LU-decomposition, Applications of Systems of Linear Equations.			
Module 2	Vector Space	Assignment	*(9Classes)*
Linear Combinations and Linear Independence, Vectors in n R^n, Linear Combinations, Linear Independence Vector Spaces, Definition of a Vector Space, Subspaces, Basis and Dimension, Coordinates and Change of Basis, Orthogonal bases and orthogonal projections.			
Module 3	Linear Transformations		*(15 lectures)*
Linear Transformations, Algebra of transformations, The Null Space and Range, Isomorphisms, Matrix Representation of Linear Transformations, Similarity Eigenvalues and			

Eigenvectors, Eigen values and Eigen vectors, Diagonalization.
Inner Product Spaces, The Dot Product on R^n and Inner Product Spaces, Orthonormal Bases, Orthogonal Complements, Application: Least Squares Approximation, Diagonalization of Symmetric Matrices, Application: Quadratic Forms.
Singular Value Decomposition: Singular values, computing singular value decomposition, and Introduction to principal component analysis.

Module 4	Vector Calculus	Assignment	*(15 lectures)*

Vector & Scalar Functions and Fields, Derivatives, Curve, Arc length, Curvature & Torsion, Gradient of Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field, Physical interpretation, solenoidal and irrotational vector fields. Problems.
Line Integrals, Path Independence of Line Integrals, Green`s Theorem in the plane, Surface Integrals, Divergence Theorem of Gauss, Stokes`s Theorem.

Targeted Application & Tools that can be used:

- Solve systems of linear equations using various methods including Gaussian and Gauss Jordan elimination and inverse matrices.
- Perform matrix algebra, invertibility, and the transpose and understand vector algebra in R^n.
- Determine relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices.
- Find eigenvalues and eigenvectors and use them in applications.
- Find the dimension of spaces such as those associated with matrices and linear transformations.
- Understand real vector spaces and subspaces and apply their properties.
- Compute inner products in a real vector space and compute angle and orthogonality in inner product spaces.
- Create orthogonal and orthonormal bases: Gram-Schmidt process and use bases and orthonormal bases to solve application problems.
- Prove basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces; linearity, injectivity and subjectivity of functions; and properties of eigenvectors and eigenvalues.

Assignment:

Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding the applications of Linear Algebra and Vector Calculus to engineering applications – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Linear Algebra and Vector Calculus is covered.

Text Book

1. Gilbert Strang, Linear Algebra and its applications, Wellesley-Cambridge Press,U.S.; 6th edition.
2. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.

References:

1. Introduction to Linear Algebra with Application, Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill
2. Elementary Linear Algebra, Applications version, Anton and Rorres, Wiley India Edition.
3. Advanced Engineering Mathematics, Erwin Kreysig, Wiley Publication.
4. Elementary Linear Algebra, Ron Larson, Cengage Learning .
5. Linear Algebra and its Applications, David C. Lay, Pearson Education.

E-resources/ Web links:

1. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_9607
2. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_143156
3. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=CUSTOM_PACKAGE_EBSCO_29052023_270975

4. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_94555 5. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_243864 6. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_224531 7. NPTEL Video Lectures Matrices and Linear Algebra: 8. https://nptel.ac.in/courses/111106051/ 9. NPTEL Video Lectures Differential Equations: 10. https://nptel.ac.in/courses/111106100/ 11. NPTEL Vector Calculus: 12. https://nptel.ac.in/courses/111/105/111105122/ 13. https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html 14. https://www.scu.edu.au/study-at-scu/units/math1005/2022/
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of Vector calculus and Linear Algebra with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem Solving. This is attained through the assessment component mentioned in the course handout.

Catalogue prepared by		Dr. Shilpa N & Dr. Manikandan
Recommended by the Board of Studies on		14th BOS held on 06/06/2025
Date of Approval by the Academic Council		

Course Code: MAT2304	Course Title: Numerical Methods, Probability Distributions and Sampling Techniques Type of Course:1] School Core	L-T- P-C	3	1	0	4
Version No.	1.0					
Course Pre-requisites	MAT2301 & MAT2302					
Anti-requisites	NIL					
Course Description	The course provides students with a comprehensive understanding of how to use computational methods to solve mathematical problems, analyze data using probability distributions, and effectively select representative samples from a larger population through various sampling techniques, equipping them to tackle real-world problems in various fields like engineering, statistics, and data science.					
Course Objective	The objective of the course is to equip students with theoretical understanding and practical skills to solve complex real-world problems using numerical approximation techniques, analyze data through probability distributions, and effectively collect representative samples using appropriate sampling methods, often applied in scientific and engineering fields.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1 - Demonstrate the applications of numerical methods to find the roots of polynomial equations and eigen values of real symmetric matrices. CO2 - Apply various numerical methods for solving linear Ordinary & Partial differential equations arising in engineering field CO3 - be able to compute conditional probabilities directly and using Bayes' theorem, and check for independence of events. CO4 - be able to set up and work with discrete & continuous random variables; in particular, to understand the Bernoulli, binomial, geometric, Poisson distributions, uniform, normal, and exponential distributions. CO5 - be able to use specific significance tests, including z-test, t-test (one- and two-sample), and chi-squared test					
Course Content:						
Module 1	Solution of Linear Systems of Equation			(8 Classes)		
Introduction, LU decomposition method, Jacobi iteration method, Gauss-Seidel iteration method. Solution of Algebraic and Transcendental Equations: Bisection method, Regula-Falsi method, Newton-Raphson method, secant method, fixed point iteration method.						
Module 2	Numerical Interpolation, Differentiation and Integration	Assignment		(10 Classes)		
Newton's method, Divided difference method, Lagrange's method, Numerical differentiation, Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Gaussian quadrature rule. Solution of ordinary differential equations: Taylor series method, modified Euler's method, Runge-Kutta method for 4th order.						
Module 3	Curve Fitting & Statistical Methods			(7 Classes)		
Curve Fitting (Straight Line ($y = a + bx$), Parabola ($y = a + bx + cx^2$), Exponential Curves ($y = ae^{bx}$, $y = ab^x$ and $y = ax^b$), Correlation - Karl Pearson's coefficient of correlation and rank						

correlation, Problems. Regression analysis - lines of regression, Problems.			
Module 4	Probability & Random Variables		(10 Classes)
Probability of an Event, Addition Law, Multiplication Law, Conditional Probability, Bayes's Theorem and Problems. Random Variables (discrete and continuous), Probability Mass/Density Functions, Mathematical Expectations, discrete probability distributions - Binomial distribution, Poisson distribution, Continuous uniform distribution - exponential distribution, normal distribution.			
Module 5	Sampling Distributions	Assignment	(10 Classes)
Random sampling, sampling distributions, Standard Error, Type I & Type II errors, Testing of Hypothesis, Test of significance - Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations, Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.			
Targeted Application & Tools that can be used: The objective of the course is to familiarize students with a variety of numerical techniques and the theoretical concepts of probability and statistics so as to equip them with the necessary numerical approaches and basic statistical tools to tackle engineering and real-life problems.			
Assignment:			
Gauss-Jacobi iteration method, Numerical differentiation, Gaussian quadrature rule for numerical integration, Probability Sampling Methods, Non-probability Sampling methods, probability sampling			
Text Book 1. Ronald .E. Walpole, Raymond. H. Myers, Sharon. L Myers, and Keying E. Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Delhi-9th edition, 2012. 2. B. S. Grewal (2017), Higher Engineering Mathematics by, 44th Edition, Khanna Publishers.			
References: 1. Miller and Freund, Probability and Statistics for Engineers, Pearson Education Ltd. 2. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley and sons, Inc.10th Edition. 3. Douglas C. Montgomery & George Runger, Applied Statistics and Probability for Engineers, Wiley Publications. E-resources/ Web links: . https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_135224 . https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_141727 . https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_217628 . https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html . https://www.scu.edu.au/study-at-scu/units/math1005/2022/			
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of calculus and differential equation with reference to specific engineering problems. The course is of both conceptual and analytical type in nature through Problem solving. This is attained through the assessment component mentioned in course handout.			
Catalogue prepared by		Dr. Nagendramma V.	
Recommended by the Board of Studies on		14th BOS held on 06/06/2025	
Date of Approval by the Academic			

Council		

Course Code: PHY2502	Course Title: Advanced Materials and Quantum Physics for Engineers Type of Course: BSC	L-T-P-C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	Class 11 and 12 physics					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the fundamentals, working and applications of optoelectronic devices and to develop the basic abilities to appreciate the applications of advanced microscopy and quantum computers. The course develops the critical thinking and analytical skills.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: To understand the concepts of electrical conducting properties of metal, semiconductor and superconductivity. CO2 To understand the principles of quantum mechanics. CO3: Discuss the quantum concepts used in quantum computers. CO4: Explain the applications of lasers and optical fibers in various technological fields.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of " Applied Physics for Electrical and Electronics cluster"and to attain the basic knowledge related to semiconductors, superconductors and dielectrics.					
Course Content:						
Module 1	Fundamentals of Materials	Assignment	No. of Classes: 10			
Topics: Concept of energy bands, Charge carriers, Carrier concentration, Concept of Fermi level, Hall effect, Magnetic Materials, Superconductors:						
Module 2	Advanced devices and Applications	Assignment	No. of Classes: 07			
p-n junctions, Zener diode, Transistor characteristics, Optoelectronic devices: Solar cells, I-V characteristics and LEDs						
Module 3	Fundamentals of Quantum Mechanics	Term paper	. No. of classes: 06			
Topics: De-Broglie hypothesis, Matter waves, Properties, de-Broglie wavelength associated with an electron, Heisenberg's Uncertainty Principle, Wave function-properties and physical significance and normalization of wave function. Wave Function in Ket Notation: Matrix form of wave function						

Module 4	Lasers And Optical Fibers	Term paper	. No. of classes :07
Interactions of radiations with matter, Characteristics of laser, conditions and requisites of laser, Modern day applications of laser. Principle of optical fibers, Numerical aperture and acceptance angle (Qualitative), Applications: Point to point communication with block diagram			
Targeted Application & Tools that can be used: 1. Areas of application are optoelectronics industry, Solar panel technologies, quantum computing software, electronic devices using transistors and diodes, memory devices, endoscopy, SQUIDS in MRI, Advanced material characterizations using SEM and STM. 2. Origin, excel and Mat lab soft wares for programming and data analysis.			
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course			
Assessment Type • Midterm exam • Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.) • Quiz • End Term Exam • Self-Learning 1. Prepare a comprehensive report on non-conventional energy resources in Karnataka and their pros and cons. 2. Write a report on importance of quantum entanglement in supercomputers.			
Text Book 1. Engineering Physics by Avadhanalu, Revised edition, S. Chand Publications,2024. 2. Principles of Quantum Mechanics by R Shankar, 2nd edition, springer Publications, 2011. 3. Introduction to Quantum Mechanics, David J Griffiths, Cambridge University Press, 2019			
References: 1. Elementary Solid state Physics: Principles and Applications by M.A. Omar, 1st Edition, Pearson Publications, 2002. 2. Optoelectronics: An Introduction by John Wilson and John Hawkes, 3rd edition, Pearson Publications, 2017. 3. Engineering Physics by Gaur and Gupta, Dhanpat Rai Publications, 2012			
Topics relevant to "SKILL DEVELOPMENT": Fundamentals of materials, Lasers and optical fibers. for Skill Development through Participative Learning Techniques. This is attained through the Assignment/ Presentation as mentioned in the assessment component in course handout.			
Catalogue prepared by	Dr. G. Srinivas Reddy , Dr. Naveen C S ,Dr. Sivasankar Reddy, , Dr. Mahaboob Pasha, .		
Recommended by the Board of Studies on	11th BOS conducted on 4th July 2024		

Date of Approval by the Academic Council	st Academic meeting held on _____

Course Code: PHY2505	Course Title: Advanced Materials and Quantum Physics for Engineers Lab Type of Course: Basic Science Course	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Class 11 and 12 physics					
Anti-requisites	NIL					
Course Description	The laboratory provides an opportunity to validate the concepts taught and enhances the ability to use the concepts for technological applications. The laboratory tasks aim to develop following skills: An attitude of enquiry, confidence and ability to tackle new problems, ability to interpret events and results, observe and measure physical phenomena, select suitable equipment, instrument and materials, locate faults in systems.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: To understand the concepts of electrical conducting properties of metal, semiconductor and superconductivity. CO2: Interpret the results of various experiments to verify the concepts used in optoelectronics and advanced devices.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of " Applied Physics for Electrical and Electronics cluster" and attain Skill Development through Experiential Learning techniques					

List of Laboratory Tasks:

Experiment No. 1: Experimental errors and uncertainty using excel

Level 1: Calculation of accuracy and precision of a given data

Level 2: propagation of errors in addition, subtraction, multiplication and division.

Experiment N0 2: To determine the wavelength of semiconductor diode Laser and to estimate the particle size of lycopodium powder using diffraction.

Level 1: Determination of Wavelength of Laser
Level 2: Finding the particle size of lycopodium powder.

Experiment No. 3: To determine the proportionality of Hall Voltage, magnetic flux density and the polarity of Charge carrier.
Level 1: To determine the proportionality of Hall Voltage and magnetic flux density
Level 2: To determine the polarity of Charge carrier.

Experiment No. 4: To study the I-V characteristics of a given zener diode in forward and reverse bias conditions.

Level 1: To study I –V characteristics of the given Zener diode in reverse bias and to determine break down voltage.
Level 2: To study I –V characteristics of the given Zener diode in forward bias and to determine knee voltage and forward resistance.

Experiment No. 5: To study input and output characteristics of a given Transistor.

Level 1: To determine the input resistance of a given transistor.
Level 2: To determine current transfer characteristics and transistor parameters of a given transistor.

Experiment No. 6: Determination of Fermi energy and Fermi temperature of a given metal and bimetallic wire.

Level 1: Determination of Fermi energy and Fermi temperature of given metal wire.

Level 2: Determination of Fermi energy and Fermi temperature of given bimetallic wire.

Experiment No. 7: To study the current vs voltage characteristics of CdS photo-resistor at constant irradiance and To measure the photo-current as a function of the irradiance at constant voltage.

Level 1 To study the current vs voltage characteristics of CdS photo-resistor at constant irradiance.
Level 2: To measure the photo-current as a function of the irradiance at constant voltage.

Experiment No. 8: To study the I-V characteristics and I-R characteristics of a solar cell as a function of the irradiance.
Level 1: To study the I-V characteristics
Level 2: I-R characteristics of a solar cell as a function of the irradiance.

Experiment No. 9: Calculate the numerical aperture and study the losses that occur in optical fiber cable. .
Level 1: Calculate the numerical aperture.
Level 2: study the losses that occur in optical fiber cable.

Experiment No. 10: To determine the magnetic susceptibility of a given diamagnetic and paramagnetic substances using Quincke's method.
Level 1: To determine the magnetic susceptibility of a given diamagnetic substance.
Level 2: To determine the magnetic susceptibility of a given paramagnetic substance.

Experiment No. 11: To study the hysteresis loop of an iron core and to find its coercivity and retentivity. To show the effect of varying voltage and frequency on hysteresis loop.
Level 1: To study the hysteresis loop of an iron core and to find its coercivity and retentivity.
.
Level 2: To show the effect of varying voltage and frequency on hysteresis loop.

Experiment No. 12: Determining the wavelength of the electrons for different accelerator voltages by applying the Bragg condition and Confirming the de Broglie equation for the wavelength.

Level 1: Determining the wavelength of the electrons for different accelerator voltages by applying the Bragg condition.
Level 2: Confirming the de Broglie equation for the wavelength.

Experiment No. 13: To measure the transition temperature and resistivity of a high temperature superconductor.
Level 1: To measure the transition temperature.
Level 2: To determine the resistivity of a high temperature superconductor.

Experiment No. 14: Plotting I-V characteristics in forward and reverse bias for LEDs and Determination of knee voltage.
Level 1: Plotting I-V characteristics in forward and reverse bias for LEDs
Level 2: Determination of knee voltage.

Experiment No. 15: Determination of Stefan's constant and verification of Stefan-Boltzmann Law.
Level 1: Determination of Stefan's constant
Level 2: Verification of Stefan-Boltzmann Law.

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

Assessment Type

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

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

Topics relevant to "SKILL DEVELOPMENT": Fundamentals of materials, Lasers and optical fibers.

for Skill Development through Participative Learning Techniques. This is attained through the Assignment/ Presentation as mentioned in the assessment component in course handout.

Catalogue prepared by	Dr. G. Srinivas Reddy , Dr. Naveen C S ,Dr. Sivasankar Reddy, , Dr. Mahaboob Pasha
Recommended by the Board of Studies on	11th BOS conducted on 4th July 2024
Date of Approval by the Academic Council	st Academic meeting held on _____

Course Code: CHE2503	Course Title: Applied Chemistry for Engineers Type of Course: Theory only	L- T-P-C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	Basic knowledge of Chemistry					
Anti-requisites	NIL					
Course Description	The primary objective of the course is to introduce the students to the concepts and applications of chemistry in Engineering. The course also aims to enhance the knowledge of chemical composition and properties of chemical molecules as electronic materials and alternate fuels. It will also cultivate in them an ability to identify chemistry in each piece of smart engineered products used in households and industry. It targets to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications. This course is designed to cater to Environment and Sustainability					
Course Objective	The objective of the course is 'SKILL DEVELOPMENT' of the student by using participative learning.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Identify the suitable materials for electronic applications 2) Outline the chemistry behind electronic materials and devices 3) Summarize the importance of various electrochemical sources in energy systems 4) Apply the knowledge of chemistry to develop high performance nanomaterials for different applications.					
Course Content:						
Module 1	Chemistry of electronic materials	Case study	Data Collection and analysis	6 Classes		
Conductors, Insulators & Semiconductors: Definition of conductors, semiconductor and insulators based on band theory, principle with examples taking Cu, Si and Quartz or any suitable example. Semiconductors: Introduction, production of electronic grade silicon from quartz i) Czochralski process (CZ) and ii) Float Zone (FZ) methods Applications of inorganic semiconductos: Gallium arsenide (GaAs), Silicon-germanium (SiGe), and Indium phosphide (InP).						
Module 2	Chemistry of advanced electronic devices	Assignment	Data Collection	10 Classes		
Display Systems: Liquid crystals (LCD) - Introduction, classification, Properties and application, Properties and application of Organic Light Emitting Diodes (OLED), Quantum Light emitting diodes (QLED) – Introduction. Organic electronics - Introduction, pentacene and fullerene derivatives, conducting polymer, principle, synthesis of polyaniline, applications in electronic devices. Memory Devices: Introduction, concepts of electronic memory. Classification of electronic memory materials -organic/polymer electronic memory devices (organic molecules, polymeric materials, organic-inorganic hybrid materials). Sensors: Materials & principles in optoelectronic sensors, piezoelectric sensors, electrochemical sensors & gas sensors, Advanced sensor technologies mimicking human						

human sensory organs (e-skin, e-nose)
Materials and mechanism in MEMS & NEMS
Smart materials (RFID & IONT): Carbon nanotubes, Graphene oxide: Structure, synthesis, electrical properties, applications in logistic information and intelligent packaging systems
E-waste Management & Green Chemistry: Introduction, sources, types, effects of e-waste on environment and human health, advantages of recycling, battery waste management, 12 principles of green chemistry

Module 3	Electrochemical and other advanced energy systems	Case study	Data analysis	7 Classes

Electrochemical energy systems:
Introduction to electrochemistry
Battery - Basic concepts of batteries and characteristics, classification –primary battery-dry cell and Li-MnO_2, secondary battery- Pb-acid, Lithium-ion batteries; Next generation batteries
Supercapacitor - classification, construction and applications in hybrid vehicles,
Fuel cells - hydrogen-oxygen, Methanol-oxygen: Principle, working and their applications.
Green hydrogen - Importance and principle of generation
Photovoltaics: Inorganic solar cells, organic solar cells, quantum dot sensitized (QDSSC's)

Module 4	Nanotechnology and Thin film fabrication	Case study	Data Collection and analysis	7 Classes

Nanotechnology: Basics of nanoscience, Chemistry and physics of nanomaterials, Introduction to nanosystem, Dimensionality and size dependent phenomena of nanomaterials, Quantum approach to explain size dependent properties, Properties at nanoscale, Classification of nanomaterials – CNTs, Nanorods, Nanotubes, Fullerenes, Nanocomposites.
Applications of nanomaterials: Solar energy conversion and catalysis, Nanoelectronics, Nanomaterials for data storage, Photonics and plasmonics, Chemical and biosensors, Application towards health and hygiene.
Nanofabrication: lithography, Nano imprinting; Characterization of nanomaterials.
Thin Film Deposition Techniques: Fabrication of thin films using CVD and PECVD and Metal organic chemical
vapor deposition (MOCVD)-principle, fabrication and applications.

Targeted Application & Tools that can be used:
Application areas are semiconducting, automobiles, electronics industry
Tools: Battery simulation tools (Battery simulator, Quantum ATK)

Project work/Assignment:

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

Assignment: 1 Report writing on recent advances in energy storage materials
Assignment 2: Identify the nanomaterials/devices you encounter in daily life

Text Book
1. Wiley, "Engineering Chemistry", Wiley.
2. Springer, "Introduction to Electronic Materials and Devices", Springer.
3. Springer, " Textbook of Nanoscience and Nanotechnology", Springer.

Reference Books
1. Advanced Semiconducting Materials and Devices, K M Gupta & Nisha Gupta (2016), Springer
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications (2018), Cambridge University Press

E resources
https://research.ebsco.com/c/n5guci/search/details/sfc3dnpvkb?db=nlebk&limiters=None&q

=chemistry%20of%20materials https://research.ebsco.com/c/n5guci/search/results?q=nanomaterials%20and%20devices&autocorrect=y&db=nlebk&expanders=concept&limiters=None&resetPageNumber=true&searchMode=boolean&searchSegment=all-results https://www.mdpi.com/books/pdfview/book/1069 https://www.mdpi.com/books/pdfview/book/333 https://www.bloomsburycollections.com/book/fuel-an-ecocritical-history/ https://eng.oversea.cnki.net/kns55	
Skill Sets Students should have skills in electrochemistry, materials science, energy storage, and semiconductor fabrication for optimizing electronic and electrical systems.	
Catalogue prepared by	Department faculties
Recommended by the Board of Studies on	XYZth BOS- 18th Dec 2024
Date of Approval by the Academic Council	

Course Code: CHE2504	Course Title: Applied Chemistry for Engineers Lab Type of Course: Laboratory only			L-T-P- C	0	0	2	1
Version No.	1.0							
Course Pre-requisites	Before undertaking this Engineering Chemistry Lab course, students are expected to possess foundational knowledge of chemistry, including an understanding of acids and bases, oxidizing and reducing agents, various types of titrations, and the proper use of laboratory glassware. Additionally, students should be familiar with handling chemicals and glassware safely and adhering to essential laboratory safety precautions							
Anti-requisites	Basic knowledge of practical chemistry							
Course Description	The laboratory course aims to develop experimental skills and apply fundamental chemical principles to address chemistry-related problems in engineering. The experiments are carefully designed to complement the theoretical concepts covered in lectures, providing hands-on experience to deepen understanding and reinforce learning.							
Course Objective	The objective of the course is to familiarize the learners with the concepts of " Engineering Chemistry Practical" and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING techniques.							
Course Outcomes (COs)	On successful completion of the course, students shall be able to: CO1. Identify the terms and applications processes involved in scientific and engineering CO2. Explain the phenomena of chemistry to describe the methods of engineering processes CO3. Analyse properties and multi-Disciplinary situations to solve the problems in chemistry that are pertinent in engineering applications CO4. Apply the basic concepts of chemistry to explain the chemical properties and processes							
Course Content:	Total 30 sessions							
Experiment 1	Experiment- 1	Experimental	Data Collection					
Determination of strength of an acid in battery electrolyte by conductometric method (battery electrolyte analysis)								
Experiment 2	Experiment-2	Experimental	Data Collection					
Potentiometric estimation of Iron using K2Cr2O7 (Electrochemical sensor)								
Experiment 3	Experiment-3	Experimental	Data Collection					
Determination of pKa of weak acid in industrial wastewater using pH meter (pH sensor)								
Experiment 4	Experiment-4	Experimental	Data Collection					
Determination of rate of corrosion of mild steel by weight loss method (Corrosion science)								
Experiment 5	Experiment-5	Experimental	Data Collection					
Estimation of Copper present in electroplating effluent by colorimeter (optical sensor)								
Experiment 6	Experiment-6	Experimental	Data Collection					
Estimation of metal in e-waste by optical sensors (Solid waste management)								
Experiment 7	Experiment-7	Experimental	Data Collection					
Synthesis of nanomaterials (material synthesis)								

Experiment 8	Experiment-8	Experimental	Data Collection	
Synthesis of conducting polymer and its conductivity measurement (material synthesis and characterization)				
Experiment 9	Experiment-9	Experimental	Data Collection	
Determination of Viscosity coefficient of lubricant by Ostwald's viscometer (Viscoelastic properties)				
Experiment 10	Experiment-10	Experimental	Data Collection	
Electroless plating of copper on metallic objects (Device fabrication)				
Experiment 11	Experiment-11	Experimental	Data Collection	
Fabrication of materials by 3D printing techniques –Demo only (digital technologies into manufacturing processes)				
Any 8 experiments will be conducted out of 11				

Continuous Internal Assessment:

- Midterm exam
- Experimental Evaluation
- Viva-voce

Text Book

1. Wiley Engineering Chemistry, WileyI ndia Pvt. Ltd.NewDelhi,2013-2ndEdition.

2. EngineeringChemistry, Satyaprakash & Manisha Agrawal, Khanna Book Publishing, Delhi

3. Essentials of Physical Chemistry, Bahl & Tuli,S. Chand Publishing

4. Vogel's text book of practical organic chemistry 5th edition
5. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.

References

Engineering Chemistry Laboratory Manual (English, Paperback, Dr Manoj Kumar Solanki), Edu-creation Publishing

E-resources:

1. https://books-library.net/files/download-pdf-ebooks.org-kupd-679.pdf

Video Links:

1. https://www.youtube.com/watch?v=-aAYjOmhkhg
2. https://www.youtube.com/watch?v=o2SkPNNGejU
3. https://www.youtube.com/watch?v=uOzniLNNxAE
4. https://www.youtube.com/watch?v=1qzpz_GQ9Gc

The topics related to Skill Development

All the experiments are relevant to Skill Development through Experiential Learning Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Faculty members of Chemistry
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

ESC Basket

<table>
<tr><td>Course Code:
CIV1200</td><td colspan="4">Course Title: Foundations of Integrated Engineering
Type of Course: Theory Only</td><td>L-T- P- C</td><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Version No.</td><td colspan="9">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">This interdisciplinary course introduces first-year engineering students to foundational principles and practices across key engineering domains, emphasizing real-world problem-solving, sustainability, and ethical innovation. Students explore how civil, mechanical, electrical, and IT systems intersect with emerging technologies like IoT, AI, and geomatics to address global challenges. Through case studies, learners gain deeper understanding of smart infrastructure, prototyping mechanical/electronic systems, and securing IT solutions. Topics include bioinformatics for environmental monitoring, GIS-enabled urban planning, renewable energy integration, and cybersecurity fundamentals. The course cultivates a holistic understanding of engineering’s role in sustainable development, safety, and ethical decision-making, preparing students to contribute meaningfully to multidisciplinary projects in a technology-driven world.</td></tr>
<tr><td>Course Objective</td><td colspan="9">The objective of the course is skill development of student by using Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">On successful completion of this course the students shall be able to:
1] Recall key principles of Agile, DevOps, and bioinformatics used in interdisciplinary engineering contexts.
2] Explain the role of GIS, LiDAR, and sustainable materials in designing smart infrastructure and disaster management systems.
3] Describe core components of mechanical systems and their real-world applications.
4] Describe the functionality of IoT-enabled wearable devices, embedded systems, and renewable energy integration in smart grids.
5] List foundational IT concepts such as cloud computing architectures, cybersecurity threats, and blockchain applications.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="2">Foundations of Engineering Practice</td><td colspan="2">Assignment</td><td colspan="2">Case studies</td><td colspan="2">6 Sessions</td></tr>
<tr><td colspan="10">Real-world problem-solving using data logic and practical applications, Collaboration and Innovation through multi-domain project, Engineering Ethics & Environmental Impact
Emerging Fields: Automation, and Introduction to bioinformatics and its application
Sustainability & Safety: Circular economy principles, carbon footprint analysis.</td></tr>
<tr><td>Module 2</td><td colspan="2">Civil Engineering & Geomatics</td><td colspan="2">Assignment</td><td colspan="2">Article Review</td><td colspan="2">6 Sessions</td></tr>
<tr><td colspan="10">Smart Infrastructure & Geomatics: GIS mapping, LiDAR, drone surveys for urban planning, Geospatial data analysis for disaster management.
Sustainable Construction: 3D-printed structures, self-healing concrete, Digital twins for infrastructure monitoring.
Green Innovations: Net-zero energy buildings, rainwater harvesting systems.</td></tr>
<tr><td>Module 3</td><td colspan="2">Mechanical Engineering in Action</td><td colspan="2">Assignment & Quiz</td><td colspan="2">Data Collection</td><td colspan="2">6 Sessions</td></tr>
<tr><td colspan="10">Advanced Manufacturing: Collaborative robots (cobots), additive manufacturing and 3D printing, Reverse engineering and prototyping.</td></tr>
</table>

Energy Systems: Solar/wind energy harvesting, piezoelectric applications.
Biomechanics: Prosthetics design, ergonomic product lifecycle.

Module 4	Electrical & Electronics Engineering	Assignment & Quiz	Data Collection and visualization	6 Sessions

Smart Devices & Systems: Embedded systems, Wearable technology, Edge computing and hardware platforms
Energy Innovations: EV charging infrastructure, wireless power transfer, Smart grid integration with renewables.

Module 5	Fundamentals of IT	Assignment & Quiz	Case studies	6 Sessions

Core IT Topics: Networking basics, Cloud computing
Cybersecurity & Data: Encryption, phishing prevention, zero-trust models, Database management.
Emerging Tech: Blockchain for supply chains, AI/ML basics, IoT integration with cloud platforms

Targeted Application & Tools that can be used:
Application Areas include Interdisciplinary problem-solving, Smart city planning, disaster management, Robotics prototyping, renewable energy systems, Wearable health tech, smart grids, Secure cloud systems.
Tools: 3D Printers, Autocad, Tinkercad, ArcGIS / QGIS, Arduino/Raspberry Pi

Text Book:

1. William Oakes & Les Leone, "Engineering Your Future: An Introduction to Engineering", Oxford University Press, 9th Edition, 2021
2. Barry F. Kavanagh, "Introduction to Geomatics", Pearson, 5th Edition, 2021
3. Ian Gibson, David Rosen, & Brent Stucker, "Additive Manufacturing Technologies", Springer, 3rd Edition, 2021
4. Sudip Misra, "The Internet of Things: Enabling Technologies, Protocols, and Use Cases", Wiley, 2nd Edition, 2022
5. James Kurose & Keith Ross, "Computer Networking: A Top-Down Approach", Pearson, 8th Edition, 2020

References

1. Supratim Choudhuri, "Bioinformatics for Beginners: Genes, Genomes, and Molecular Evolution", Academic Press, 1st Edition, 2023,
2. Robert McGinn, "The Ethical Engineer: Contemporary Concepts and Cases", Princeton University Press, 1st Edition, 2020
3. Charles J. Kibert, "Sustainable Construction: Green Building Design and Delivery", Wiley, 5th Edition, 2022
4. Anthony M. Townsend, "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", W.W. Norton & Company, 1st Edition, 2020
5. David Buchla, "Renewable Energy Systems: A Smart Energy Systems Approach", Pearson, 2nd Edition, 2023
6. Charles Platt, "Make: Electronics: Learning Through Discovery", Make Community, 3rd Edition, 2021
7. Charles J. Brooks, Christopher Grow, & Philip Craig, "Cybersecurity Essentials", Wiley, 2nd Edition, 2021

Web-resources:

1. Post-parametric Automation in Design and Construction

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1155197&site=ehost-live

2. Smart Cities : Introducing Digital Innovation to Cities

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1993146&site=ehost-live

3. Innovation Energy: Trends and Perspectives or Challenges of Energy Innovation https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=2323766&site=ehost-live 4. Additive Manufacturing: Opportunities, Challenges, Implications https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1134464&site=ehost-live	
Catalogue prepared by	Dr. Nakul Ramanna, Dr. Rajiv Ranjan Singh, Mr. N. Gopalakrishnan, Mr. Ajay H A
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: MEC1006	Course Title: Engineering Graphics Type of Course: 1] Professional Core Course 2] Theory	L-T- P-C	2	0	0	2
Version No.	1.2					
Course Pre-requisites	NIL					
Anti-requisites	CAMD					
Course Description	The course is designed with the objective of giving an overview of engineering drawing with the help of software tools. It is introductory in nature and acquaints the students with the techniques used to create engineering drawings with computerized drafting tools. Computerized drafting provides accurate and easily modifiable graphic entities, easy data storage, easy retrieval facility and it enhances creativity. It will expose students to the concept of engineering drawing and teach them to draw different views of planes and solids in different orientations. The course will teach students to use AutoCAD to produce engineering drawings. They will learn to create drawing layouts, dimensioning, the theory of projection, orthographic projection of points, lines, planes and solids, isometric projection and be introduced to the development of surfaces.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Engineering Graphics" and attain SKILL DEVELOPMENT through Problem solving methodologies.					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe competency of Engineering Graphics as per BIS conventions and standards. (2) Illustrate the theory of projection for drawing projections of Points, Lines and Planes under different conditions. (3) Prepare multiview orthographic projections of Solids by visualizing them in different positions. (4) Prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions.					
Course Content						
Module 1	Introduction to Drawing	Assignment	Standard technical drawing	4 sessions		
Topics: Introduction, drawing instruments and their uses, relevant BIS conventions and standards, Lettering, Line conventions, dimensioning, Selection of drawing sheet size and scale.						
Module 2	Orthographic projections of Points, Straight Lines and Plane Surfaces	Assignment	Projection methods Analysis	10 sessions		
Topics: Introduction, Definitions – Elements of projection and methods of projection, Planes of projection, reference line and conventions adopted. First angle and third angle projections. Projection of Points in all 4 quadrants.						

Projections of Straight Lines (located in first quadrant/first angle projection only): True and apparent lengths, true and apparent Inclinations to reference planes. (No application problems). Projection of Plane surfaces (First angle projection): Regular plane surfaces – triangle, square, rectangle, pentagon, hexagon and circle – in different positions inclined to both the planes using change of position method only.				
Module 3	Orthographic Projections of Solids	Assignment	Multi-view drawing Analysis	8 sessions
Topics: Introduction, Projection of right regular prisms, pyramids, cone, hexahedron and tetrahedron in different positions (Problems resting on HP only and First angle projection).				
Module 4	Isometric Projections of Solids (Using isometric scale only)	Assignment	Spatial Visualization	8 sessions
Topics: Introduction, Isometric scale, Isometric projections of right regular prisms, cylinders, pyramids, cones and their frustums, spheres and hemispheres, hexahedron (cube), and combination of 2 solids, conversion of orthographic view to isometric projection of simple objects.				
Targeted Application & Tools that can be used: Application Area is in understanding and interpreting an object in various positions and converting it into a technical drawing which can be universally accepted. Professionally Used Software: AutoCAD				
Text Book: 1.N. D. Bhatt, "Engineering Drawing: Plane and Solid Geometry," Charotar Publishing House Pvt. Ltd.				
References: 1. K.R. Gopalakrishna, "Engineering Graphics", Subhash Publishers, Bangalore. 2. D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, "Engineering Graphics with AutoCAD," Prentice Hall. 3. D. A. Jolhe, "Engineering Drawing with Introduction to AutoCAD," Tata McGraw Hill. 4. Engineering Graphics Manual provided by Instructor in charge. Webresources : Knimbus - Your Library. Anywhere, Anytime.				
Topics relevant to "SKILL DEVELOPMENT": Projection in first and third angle for SKILL DEVELOPMENT through Problem Solving methodologies. This is attained through the assessment component mentioned in the course handout.				

Catalogue prepared by	Mr. Yeshwanth D
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 27/08/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 03/08/2022.

<table>
<tr><td>Course Code: EEE1200</td><td colspan="3">Course Title: Basics of Electrical and Electronics Engineering.
Type of Course: Engineering Science - Theory</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">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.</td></tr>
<tr><td>Course Objective</td><td colspan="8">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:

4. Explain basic laws of Electrical Engineering to compute voltage, currents and other parameters in the circuits.
5. Discuss various fundamental parameters appearing in the characteristics of semiconductor devices and their applications.
6. Summarize the operations of different biasing configurations of BJTs and amplifiers.
7. Summarize the performance characteristics and applications of various electrical Machines.
8. Demonstrate the working of electrical machines to observe performance characteristics
9. 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="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Electrical Circuits</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td colspan="4">10 Sessions</td></tr>
<tr><td colspan="9">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</td></tr>
</table>

examples.

Introduction to three phase system and relation between line and phase values in Star & Delta connection, Numerical examples.

Module 2	Semiconductor and Diode applications	Assignment/ Quiz	Memory Recall based Quizzes	11 Sessions

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.

Module 3	Fundamentals of Electrical Machines	Assignment/ Quiz	Memory Recall-based Quizzes	12 Sessions

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.

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):

3. Kothari D. P. & Nagrath I. J., "Basic Electrical and Electronics Engineering", Tata McGraw-Hill Education.
4. 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.
5. A.P.Malvino, Electronic Principles,7thEdition, Tata McGraw Hill,2007
6. J. Millman, C. C. Halkias and C. D. Parikh, "Millman's Integrated Electronics", McGraw Hill Education, 2nd Edition.
7. Basics of Electrical & Electronics Laboratory Manual.

Reference Book (s):

4. John Hiley, Keith Brown and Ian McKenzie Smith, "HUGHES Electrical and Electronic Technology", 10th Edition (Indian Edition published by Dorling Kindersley), Pearson,2011
5. Samarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd

Edition, Prentice Hall India, 2007.
6. K Uma Rao, A Jaya Lakshmi, "Basic Electrical engineering" IK International publishing house Pvt. Ltd
7. R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education India 7th Edition.
8. A K. Maini, V. Agrawal, "Electronic Devices & Circuits", Wiley, 2nd Edition
9. A.S Sedra, K. C. Smith, "Microelectronic Circuits", Oxford University Press, 6th Edition

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

4. https://presiuniv.knimbus.com/user#home
5. https://www.digimat.in/nptel/courses/video/108105112/L01 "Fundamentals of Electrical Engineering-Basic Concepts, Examples"
6. Seminar Topic: https://nptel.ac.in/courses/108/105/108105153/ "Electrical Measurements"
7. 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
8. Video lectures on "Analog Electronics" by Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/108/102/108102095/
9. Video lectures on "Diodes", by Prof. Chitralekha Mahanta, IIT Guwahati, https://nptel.ac.in/courses/117/103/117103063/
10. "Introduction to Electrical Machines https://nptel.ac.in/courses/108/102/108102146/"
11. 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
12. 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
13. 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
14. 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: EEE1250	Course Title: Basics of Electrical and Electronics Engineering Lab. Type of Course: Engineering Science - Lab	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: 1. Demonstrate the working of electrical machines to observe performance characteristics. 2. 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): 8. 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: ECE1511	Course Title: Design Workshop	L- T-P- C	1	0	2	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course is designed to provide an in-depth understanding of Arduino, microcontrollers Raspberry pi and their application in various real time projects involving sensors. Throughout the course, students will learn the fundamentals of Arduino and Raspberry Pi programming and gain hands-on experience with a wide range of sensors. Students will explore how to connect and interface sensors with Arduino and Raspberry Pi boards, read sensor data, and use it to control various output devices This course is suitable for beginners who are interested in exploring the world of electronics and developing practical applications using Arduino, Raspberry Pi and sensors.					
Course Objective	The objective of the course is Employability Skills of student by using PARTICIPATIVE LEARNING techniques.					
Course Outcomes	On successful completion of the course the students shall be able to CO1 Interpret Boolean laws and the logic gates functionality using available circuit elements in simulator platforms. CO2 Apply the fundamental laws and rules of Boolean algebra for simplified circuit simulation using any simulator tool. CO3 Develop combinational logic circuits by connecting offered gates for basic arithmetic operation CO4 Make use of circuit elements for ensuring the digital logic circuit's truth table perfection. CO5 Examine the performance of sequential logic circuit simulation using flip-flop and latch elements CO6 Demonstrate the operation of clocked and edge-triggered sequential components in an open-source simulation environment					
Course Content:						
Module 1	Basic concepts of Microcontrollers	Hands-on	Interfacing Task and Analysis	3 Sessions		
Topics: Introduction to Arduino, ESP and Node MCU Pin configuration and architecture, Device and platform features, Concept of digital and analog ports, Familiarizing with Arduino Interfacing Board, API's , Introduction to Embedded C and Arduino platform, Arduino Datatypes and variables, Arduino i/o Functions, Arduino Communications, Arduino IDE, Various Cloud Platforms.						
Module 2	Sensory Devices	Hands-on	Interfacing Task and Analysis	3 Sessions		
Topics: Arduino Sensors: Humidity Sensor, Temperature Sensor, Water Detector / Sensor, PIR Sensor, Ultrasonic Sensor, Connecting Switches and actuators, sensor interface with Arduino.						

Introduction to 3D Printer: 3D Printer technology and its working Principles, Applications. Introduction to online Simulators: Working with AutoCAD/Fusion 360 Simulator.

Module 3	Introduction to Micro python	Hands-on	Interfacing Task and Analysis	4 Sessions

Topics:
Introduction to Micro Python, Comparison with other programming languages, Setting up the Micro Python development environment, Basics of Micro Python syntax and structure.

Module 4	Working with Raspberry-pi	Hands-on	Interfacing Task and Analysis	5 Sessions

Introduction to raspberry pi boards, pin-diagram, different types of raspberry pi boards and its application, LED and switch control. Mastering Modules, Setup Raspberry - PuTTY SSH, VNC Viewer to interface with more complicated sensors and actuators. Various Libraries and its functions.

Lab: Name of the Experiments:

1. Introduction Lab 1:
   Level 1: Overview on Arduino based Micro-controller, and sensors.
   Level 2: Interfacing of Arduino and ESP boards with sensors and other components.
2. Lab 2: Smart Plant Monitoring
   Level 1- Push button-controlled LED.
   Level 2- Automatic Irrigation and monitoring System using Arduino
3. Lab 3: Robotics with Arduino.
   Level 1- Servo Motor control using Arduino
   Level 2: DC Motor Control Using Arduino for Robotics.
4. Lab 4: Environmental pollution using ESP.
   Level 1 - IoT based air Pollution Monitoring System.
   Level 2- IoT Based water pollution system
5. Introduction Lab for raspberry pi:
   Level 1: Overview on Different Raspberry Pi Boards, and sensors.
   Level 2: Configuring the Raspberry Pi and Interfacing with sensors and other components.
6. Lab 7: Raspberry Pi based Object Detection using TensorFlow and OpenCV.
7. Lab 8: Speech Recognition on Raspberry Pi for Voice Controlled Home Automation.
8. Lab 9: Design the website using HTML and CSS, and host the website on Raspberry Pi.
9. Introduction Lab for 3D printing:
   Overview of 3D printing. Design of 3D structure using the CAD. Understand the steps of fabrication of simple rectangular box using 3D printer.
10. Lab 10: Design and print of Hollow Cylindrical structure using 3D CAD and 3D printer.
11. Lab 11 Demonstration of Jetson nano board and its capability. (OPTIONAL)
12. Lab 12: Revision
13. Lab 13: Revision
14. Lab 14: Mini Project
15. Lab 15: Mini Project Evaluation.

Topics: Types of Arduino boards, Thonny Python, Python IDLE, sensors, 3D Printer

Targeted Application & Tools that can be used:
Application Area:
Home Automation, Environmental Monitoring, Agriculture and Farming, Industrial Automation, Internet of Things (IoT), Robotics, Wearable Devices, Security Systems, Education and Learning. These are just a few examples of the many application areas where Arduino, Raspberry Pi and sensors can be applied. The flexibility and affordability of Arduino, and Raspberry Pi combined with the wide range of sensors available, allow for endless possibilities in creating innovative projects.

Professionally Used Software: Students can use open SOURCE Software's Arduino IDE and Tincker CAD, Thonny Python, Python IDLE etc.

Project work/Assignment:

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

Textbook(s):

1. Monk Simon "Programming Arduino: Getting Started with Sketches", Mc Graw Hill Publications Second Edition
2. Monk Simon "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", Publisher(s): O'Reilly Media, Inc. ISBN: 9781098130923 fourth Edition.

References

Reference Book(s)

1. Neerparaj Rai "Arduino Projects for Engineers" BPB publishers,first edition, 2016.
2. Ryan Turner "Arduino Programming " Nelly B.L. International Consulting Ltd. first edition,2019.
3. Charles Bell Micro Python for the Internet of Things: A Beginner's Guide to Programming with Python on Microcontrollers" by" Edition 1, 2017, ISBN 978-1-4842-3123-4
4. Stewart Watkiss "Learn Electronics with Raspberry Pi " Apress Berkeley, CA . second edition,2020. ISBN978-1-4842-6348-8
5. Jo Prusa, "Basic of 3D printing", Prusa Research, 3rd edition.
6. Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi (Series in Sensors)", CRC Press, 1st Edition. 2018.

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

1. Arduino trending Projects < https://www. https://projecthub.arduino.cc/>
2. Introduction to Arduino < https://onlinecourses.swayam2.ac.in/aic20_sp04/preview>
3. Case studies on Wearable technology< https://www.hticiitm.org/wearables>
4. Raspberry-pi Projects < https://magpi.raspberrypi.com/articles/category/tutorials/>
5. Introduction to internet of things< https://nptel.ac.in/courses/106105166>

E-content:

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

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

3. R. Maheswar, P. Jayarajan, S. Vimalraj, G. Sivagnanam, V. Sivasankaran and I. S. Amiri, "Energy Efficient Real Time Environmental Monitoring System Using Buffer Management Protocol," 2018, pp. 1-5, doi: 10.1109/ICCCNT.2018.8494144. https://ieeexplore.ieee.org/document/8494144.

4. Yaser S Shaheen,Hussam., " Arduino Mega Based Smart Traffic Control System ," December 2021 Asian Journal of Advanced Research and Reports 15(12): 43-52, 2021(15(12): 43-52, 2021):15(12): 43-52, 2021.

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

6. Supriya S, 2Dr. Aravinda " Green leaf disease detection and identification using Raspberry

Pi https://www.irjet.net/archives/V9/i8/IRJET-V9I847. **7.** Dr. E.N. Ganesh., "Health Monitoring System using Raspberry Pi and IOT" DOI : http://dx.doi.org/10.13005/ojcst12.01.03	
Topics relevant to development of "SKILL": System design for achieving Sustainable Development Goals.	
Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	BOS NO:
Date of Approval by the Academic Council	Academic Council Meeting No. ___ dated on _____

Course Code: CSE2280	Course Title: C Programming and Data Structures Type of Course: Theory	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Prerequisites	The student needs to have a fundamental understanding of computers and basic syntax of programming language.					
Anti-requisites	NIL					
Course Description	C Programming and Data Structures course aims to teach fundamental programming concepts in C, alongside essential data structures for organizing and manipulating data efficiently. The course covers topics like data types, control structures, functions, arrays, and introduces more advanced concepts like memory management, file handling, and various data structures such as arrays, linked lists, stacks, and queues.					
Course Objective	The objective of this course is to equip learners with a comprehensive understanding of the C programming language and fundamental data structures. Through theoretical knowledge and practical implementation, students will gain the ability to design, implement, and apply efficient data storage and manipulation techniques to solve computational problems effectively. This course aims to develop strong problem-solving skills and a foundation for further studies in computer science.					
Course Outcomes	On successful completion of the course the students shall be able to: C.O. 1: Explain the fundamental concepts of C programming, including data types, operators, control flow, and functions. [Understanding] C.O. 2: Develop C programs utilizing advanced features such as structures, unions, pointers, and file handling. [Application] C.O. 3: Implement various linear data structures like arrays, linked lists, stacks, and queues in C to solve specific problems. [Application] C.O. 4: Apply non-linear data structures such as binary trees and hashing techniques for efficient data organization and retrieval. [Application] C.O. 5: Analyze and implement different sorting and searching algorithms in C for efficient data manipulation. [Analysis]					
Course Content:						
Module 1	C Programming Fundamentals	Assignment		10 Sessions		
Topics: Data Types – Variables – Operations – Expressions and Statements, Conditional Statements, Functions – Recursive Functions						
Module 2	C Programming – Advanced Features	Assignment		11 Sessions		
Topics: Structures – Union – Enumerated Data Types, Pointers: Pointers to Variables, Arrays, and Functions File Handling, Pre-processor Directives						
Module 3	Linear Data Structures	Term paper/Assignment		11 Sessions		
Topics: Abstract Data Types (ADTs) – List ADT – Array-Based Implementation, Linked List – Singly, Doubly- Linked Lists – Circular Linked List, Stack ADT – Implementation of Stack – Applications, Queue ADT – Priority Queues – Queue Implementation – Applications						

Module 4	Non-linear Data Structures	Term paper/Assignment		11 Sessions

Topics:
Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree, Hashing – Hash Functions – Separate Chaining – Open Addressing – Linear Probing – Quadratic Probing – Double Hashing – Rehashing. Insertion Sort – Quick Sort – Heap Sort – Merge Sort-Linear Search – Binary Search

Targeted Application & Tools that can be used:

Text Book(s):

T1. Pradeep kothari "Android Application Development - Black Book", dreamtechpress
T2. Barry Burd (Author), "Android Application Development" ALL – IN – ONE FOR Dummies
T3. Jeff Mcherter (Author),Scott Gowell (Author), "Professional mobile Application Development" paperback, Wrox - Wiley India Private Limited
T4. Wei-Meng Lee (Author) "Beginning Android Application Development" Wrox – Wiley India Private Limited

Reference(s):

1. "C PROGRAMMING AND DATA STRUCTURES for BE Anna University R21CBCS (III-ECE/EEE - CS3353)" by A. A. Puntambekar (Technical Publications, 2022)
2. "Data Structures and Algorithms Using C" by Amitava Nag & Jyoti Prakash Singh (S. Chand Publishing)
3. "PROGRAMMING IN C AND DATA STRUCTURES" by B.K.Mathan Nagan and T.Mahalakshmi (Charulatha Publications)

E-Resources: https://puniversity.informaticsglobal.com/login Or http://182.72.188.193/

Course Code: CSE2281	Course Title: C Programming and Data Structure Type of Course: Lab	L- T- P- C	0	0	3	3
Version No.	1.0					
Course Prerequisites						
Anti-requisites	NIL					
Course Description	A "C Programming and Data Structures Lab" course aims to provide practical experience in implementing data structures and algorithms using the C programming language. The lab focuses on hands-on learning, enabling students to develop C applications, implement data structures like arrays, linked lists, stacks, queues, and trees, and apply sorting and searching algorithms. Students will also learn about memory management, file handling, and other advanced C programming concepts.					
Course Objective	The primary course objectives of a C Programming and Data Structure Lab are to equip students with practical programming skills in C, to enable them to implement various data structures, and to familiarize them with fundamental algorithms like sorting and searching. Specifically, the course aims to develop C applications, implement linear and non-linear data structures, understand tree operations, and implement sorting and searching algorithms.					
Course Outcomes	On successful completion of the course the students shall be able to: C.O. 1: Explain the fundamental concepts of C programming, including data types, operators, control flow, and functions. [Understanding] C.O. 2: Develop C programs utilizing advanced features such as structures, unions, pointers, and file handling. [Application] C.O. 3: Implement various linear data structures like arrays, linked lists, stacks, and queues in C to solve specific problems. [Application] C.O. 4: Apply non-linear data structures such as binary trees and hashing techniques for efficient data organization and retrieval. [Application] C.O. 5: Analyze and implement different sorting and searching algorithms in C for efficient data manipulation. [Analysis]					
Course Content:						
Module 1	C Programming Fundamentals	Assignment		10 Sessions		
Write a C program to declare variables of different data types (integer, float, char, double) and perform basic arithmetic operations (+, -, *, /). Display the results with appropriate formatting. Conditional Statements: Write a C program to determine if a given integer is positive, negative, or zero using if-else statements. Write a C program to find the largest of three numbers entered by the user using nested if-else or if-else if-else statements. Loops: Write a C program to print the first n natural numbers using a for loop. Write a C program to calculate the factorial of a given number using a while loop. Functions: Write a C program to define a function add(int a, int b) that returns the sum of two integers. Call this function from the main function and display the result.						

Write a C program to calculate the area of a circle using a function that takes the radius as input.
Arrays:
Write a C program to read 5 integer values into an array and display them.
Write a C program to find the sum and average of elements in an integer array.
An embedded system for a smart home needs to track the power consumption of three appliances over a day (in hourly intervals). Write a C program that takes 24 hourly power readings for each of the three appliances, stores them in 2D arrays, and then calculates and displays:
The total power consumed by each appliance for the day.
The appliance with the highest total power consumption.
The average power consumption across all appliances for each hour.
Scenario: Simple Calculator with Error Handling:
Develop a C program that acts as a simple calculator. It should take two numbers and an operator (+, -, *, /) as input. Implement functions for each operation. Include error handling to prevent division by zero and handle invalid operator input, displaying appropriate error messages.

Module 2	C Programming - Advanced Features	Assignment		15 Sessions

Define a structure to store the details of a student (roll number, name, marks in three subjects). Write a C program to read the details of a student and display them.
Demonstrate the use of a union to store either an integer or a floating-point value and print the stored value.
Pointers:
Write a C program to demonstrate the use of pointers to access and modify the value of an integer variable.
Write a C program to swap two numbers using pointers.
Pointers and Arrays:
Write a C program to access the elements of an array using pointer arithmetic.
Write a C program to pass an array to a function using pointers and calculate the sum of its elements within the function.
File Handling:
Write a C program to create a text file and write a few lines of text into it.
Write a C program to read the contents of a text file and display them on the console.
Preprocessor Directives:
Write a C program that uses #define to define a constant for the value of PI and uses it to calculate the area of a circle.
Demonstrate the use of #include to include a standard header file (e.g., stdio.h, math.h).
Higher-Level Thinking (Scenario-Based):

Scenario: Data Logging for a Sensor:
A temperature sensor is connected to a microcontroller. Write a C program that simulates reading temperature values at regular intervals (e.g., every 5 seconds). Store these readings along with a timestamp in a file. The program should also include a preprocessor directive to define the maximum number of readings to be stored.
Scenario: Student Record Management using Structures and Files:
Design a structure to store student records (name, roll number, total marks). Write a C program that allows the user to:
Add new student records to a file.
Read and display all student records from the file.
Search for a student record based on their roll number.

Module 3	Linear Data Structures	Term paper/Assignment		15 Sessions

Array-Based List Operations:
Write a C program to implement a simple array-based list with operations to insert an element at the end, delete the last element, and display the list.

Linked List Operations:
Write a C program to create a singly linked list and perform the following operations:
Insert a node at the beginning.
Display all the nodes in the list.
Stack Implementation using Arrays:
Write a C program to implement a stack using an array with push and pop operations. Demonstrate the stack operations.
Queue Implementation using Arrays:
Write a C program to implement a queue using an array with enqueue and dequeue operations. Demonstrate the queue operations.
Higher-Level Thinking (Scenario-Based):

Scenario: Simulation of a Simple Call Center Queue:
Model a simple call center queue using a linked list. Each node in the list represents a waiting customer. Implement functions to:
Add a new customer to the queue (enqueue).
Serve the next customer in the queue (dequeue).
Display the current number of customers in the queue.
Scenario: Undo/Redo Functionality using Stacks:
Simulate a basic text editor's undo/redo functionality using two stacks. One stack will store the sequence of actions performed (e.g., typing a character), and the other will store the undone actions. Implement functions for type, undo, and redo.

Module 4	Non-Linear Data Structures	Term paper/Assignment		15 Sessions

Binary Tree Traversal:
Create a simple binary tree (manually insert a few nodes). Write C programs to perform inorder, preorder, and postorder traversals of the tree and print the node values.
Binary Search Tree Operations:
Write a C program to insert nodes into a binary search tree and then search for a specific key in the tree.
Hashing:
Implement a simple hash function and demonstrate the insertion of a few key-value pairs into a hash table using separate chaining.
Sorting Algorithms:
Write a C program to implement the insertion sort algorithm and sort a given array of integers.
Write a C program to implement the bubble sort algorithm and sort a given array of integers.
Searching Algorithms:
Write a C program to implement linear search to find a given element in an array.
Write a C program to implement binary search to find a given element in a sorted array.
Higher-Level Thinking (Scenario-Based):
Scenario: Representing a Circuit Hierarchy using Trees:
Consider an electronic circuit with components and sub-circuits. Design a tree structure where each node represents a component or a sub-circuit. The root can represent the main circuit. Write a C program to:
Create a representation of a simple circuit hierarchy (manually insert nodes).
Implement a function to traverse the tree and print the names of all the components in a specific order (e.g., preorder to represent the overall structure first).
Scenario: Efficient Data Retrieval for Component Database using Hashing:
Imagine a database storing information about electronic components (part number, description, cost). Implement a hash table to store and retrieve component information based on the part number. Handle collisions using separate chaining. Write functions to:
Insert new component information.
Retrieve component information given a part number.
Scenario: Sorting Electronic Components based on Value:
You have an array of electronic components, each with a specific value (e.g., resistance,

capacitance). Write a C program to sort these components in ascending order of their value using an efficient sorting algorithm like quicksort or mergesort.

Text Book(s):

1. "C PROGRAMMING AND DATA STRUCTURES for BE Anna University R21CBCS (III-ECE/EEE - CS3353)" by A. A. Puntambekar (Technical Publications, 2022)
2. "Data Structures and Algorithms Using C" by Amitava Nag & Jyoti Prakash Singh (S. Chand Publishing)
3. "PROGRAMMING IN C AND DATA STRUCTURES" by B.K.Mathan Nagan and T.Mahalakshmi (Charulatha Publications)

Course Code: CSE1700	Course Title: Essentials of AI Type of Course: Program Core Course - Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces the student to the basics of artificial intelligence. In this course, the student first learns the various search methods for problem-solving, followed by knowledge-based logic representations. After that, the student will learn about uncertainty in AI, as well as approaches to solve such challenges such as Naïve Bayes Classifier and Hidden Markov Models. Topics: Uninformed search, Heuristic search, Local search, Adversarial search, Constraint satisfaction, logic, First Order Resolution, Probability, Naïve Bayes Classifier, and Hidden Markov Model (HMM).					
Course Objectives	The objective of the course is EMPLOYBILITY of student by using EXPERIENTIAL LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: 1. Explain different methods of searching, proving, and analysis in AI [Understand] 2. Implement various graphical and adversarial search algorithms. [Apply] 3. Prove, by resolution, different situations using First Order Logic [Apply] 4. Solve sequence labeling problems using HMM [Apply]					
Course Content:						
Module 1	Search Methods for Problem-Solving	Problem-Solving Tests	NPTEL Assignments	No. of Sessions: 13		
Introduction – History of AI, Agents and Environment, Types of AI and Learning. State Space Search; General Formulation of Search Problems; Data Structures used in Searching. Uninformed Search Algorithms – Breadth First Search, Depth First Search, Uniform Cost Search, Generalized Uniform Cost Search (a.k.a Dijkstra's Single-Source Shortest Path), Iterative Deepening Depth-First Search, Time and Space Complexity Analysis of Uninformed Search Algorithms. Heuristic Search Algorithms – Heuristics and Admissibility, Greedy Best-First Search, A* Search and weighted A* Search.						
Module 2	Advanced Search Methods	Problem-Solving Tests	NPTEL Assignments	No. of Sessions: 12		
Local Search – Local Search, Hill Climbing, Genetic Algorithms, Gradient Descent. Adversarial Search – Minimax Search, Alpha-Beta Pruning, Ideal Ordering. Constraint Satisfaction – Constraint Satisfaction Problems Definitions and Examples – Map Colouring, N Queens, Cryptarithmetic, Generalized CSP; Back-tracking Heuristics; Arc Consistency and Path Consistency						
Module 3	Knowledge-Based Logic	Automated Theorem Proving	NPTEL Assignments	No. of Sessions: 10		

	Representation	using FOL Resolution		
Propositional Logic – Syntax and Semantics of Propositional Logic. Logical connectives. Inference Rules. Conjunctive and Disjunctive Normal Forms. First Order Logic – Syntax and Semantics of Propositional Logic. Logical connectives. Inference Rules. Conjunctive and Disjunctive Normal Forms. Resolution – Resolution Principle. Propositional and First Order Resolution. Applications for solving story problems using Resolution				
Module 4	Uncertainty in AI	Representing problems as HMM	NPTEL Assignments	No. of Sessions: 06
Probability – Probability Definitions. Conditional Probability. Bayes Theorem. Naïve Bayes Classifier. Using Naïve Bayes Classifier for Supervised Learning. Hidden Markov Models – Definition of HMM. Sequence Labeling and Markov Assumption. Sub-Problems in HMM and their solutions – Forward Probability and Viterbi Algorithm. Applications of Sequence Labeling in Natural Language Processing (Eg. Part-of-Speech Tagging). Introduction to Deep Learning – Artificial Neurons, Activation Functions, Multilayer Perceptron.				

Targeted Application & Tools that can be used:

1. Implementation of a shortest-path finder using different search algorithms.
2. Implementation of a sequence labeler using Viterbi Algorithm.

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

1. Group project on one of the topics mentioned above (Eg. Adversarial search).

Textbook(s):

1. Stuart Russel and Peter Norvig. *Artificial Intelligence: A Modern Approach*. 4th Edition. Pearson Education. 2022.
2. Lavika Goel. *Artificial Intelligence: Concepts and Applications*. 1st Edition. Wiley. 2021.
3. Elaine Rich, Kevin Knight and Shivashankar B Nair. *Artificial Intelligence*. 4th Edition. MedTech Science Press. 2024.

References:

1. Deepak Khemani. *A First Course in Artificial Intelligence*. 1st Edition. 6th Reprint, 2018.
2. Munesh Chandra Trivedi. *A Classical Approach to Artificial Intelligence*. 2nd Edition. Khanna Publishers. 2018.
3. George Luger. *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*. 6th Edition. Pearson Education. 2021.

Weblinks

1. NPTEL Courses: Mausam (IIT Delhi), "An Introduction to Artificial Intelligence" Link: https://nptel.ac.in/courses/106102220.
2. Shyamanta M. Hazarika (IIT Guwahati), "Fundamentals of Artificial Intelligence". Link: https://nptel.ac.in/courses/112103280. Useful for the full course.
3. Deepak Khemani (IIT Madras), "Artificial Intelligence: Search Methods for Problem-Solving". Link: https://nptel.ac.in/courses/106106226. Useful for Module 1 and 2
4. Deepak Khemani (IIT Madras), "Artificial Intelligence: Knowledge Representation and Reasoning". Link: https://nptel.ac.in/courses/106106140. Useful for Module 3.
5. Deepak Khemani (IIT Madras), "AI: Constraint Satisfaction". Link: https://nptel.ac.in/courses/106106158. Useful for Module 2.

Catalogue prepared by	Dr. Sandeep Albert Mathias
Recommended by the Board	BOS NO: SOCSE 2nd BOS held on 17/03/25

of Studies on	
Date of Approval by the Academic Council	Academic Council Meeting No 21, Dated 17/03/25

Course Code: CSE1701	Course Title: Essentials of AI Lab Type of Course: Program Core Course - Lab	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces the student to the basics of artificial intelligence. In this course, the student first learns the various search methods for problem-solving, followed by knowledge-based logic representations. After that, the student will learn about uncertainty in AI, as well as approaches to solve such challenges such as Naïve Bayes Classifier and Hidden Markov Models. Topics: Uninformed search, Heuristic search, Local search, Adversarial search, Constraint satisfaction, logic, First Order Resolution, Probability, Naïve Bayes Classifier, and Hidden Markov Model (HMM).					
Course Objectives	The objective of the course is EMPLOYBILITY of student by using EXPERIENTIAL LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: 5. Explain different methods of searching, proving, and analysis in AI [Understand] 6. Implement various graphical and adversarial search algorithms. [Apply] 7. Prove, by resolution, different situations using First Order Logic [Apply] 8. Solve sequence labeling problems using HMM [Apply]					
Course Content:						No. of Sessions: 15 (30 hours)

Experiment No. 1: File Handling
Level 1: Read text files using Python
Level 2: Parse text files using Python

Experiment No. 2: Implementation of Graph Representations
Level 1: Implement graph representations by taking input from the console
Level 2: Implement graph representations by taking input from files.

Experiment No. 3 & 4: Implementation of Uninformed Search Algorithms
Level 1: Implement uninformed search algorithms – BFS and DFS – on unweighted graphs.
Level 2: Implement uninformed search algorithms – Uniform Cost Search and Dijkstra's SSSP – on weighted graphs

Experiment No. 5: Implementation of Heuristic Search Algorithms
Level 1: Calculate the upper-bounds of admissible heuristics using Dijkstra's SSSP.

Level 2: Implement Greedy Best-First Search and A* Search Algorithms.

Experiment No. 6 & 7: Implementation of Adversarial Search
Level 1: Implement a Game Tree
Level 2: Perform Alpha-Beta Pruning and Ideal Ordering

Experiment No. 8 & 9: Implementation of a CSP Solver
Level 1: Implement a CSP solver to solve a cryptarithmetic problem
Level 2: Implement a CSP solver for map colouring

Experiment No. 10: Using Python Packages for CSP
Level 1: Implement a CSP solver for Sudoku
Level 2: Implement a CSP solver for Addoku

Experiment No. 11: Implement a Family Tree Parser
Level 1: Perform logic programming using logpy.
Level 2: Implement a family tree parser

Experiment No. 12 & 13: Implement a Decision Maker
Level 1: Implement a Minesweeper solver
Level 2: Implement a Battleship solver

Experiment No. 14 & 15: Hidden Markov Model
Level 1: Implement a generic HMM
Level 2: Build a PoS Tagger using a HMM with the Brown Corpus and the Universal Dependencies Tagset.

Targeted Application & Tools that can be used:

3. Google Colab
4. Python IDEs like PyCharm

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

The course is a lab-based course with all the assessments centrally evaluated. Every experiment consists of two sessions. The first session involves exploring a solution to the problem. The second session involves solving a particular problem.

Textbook(s):

1. Stuart Russel and Peter Norvig. *Artificial Intelligence: A Modern Approach*. 4th Edition. Pearson Education. 2022.
2. Prateek Joshi and Alberto Artasanchez. *Artificial Intelligence with Python*. 2nd Edition. Packt. 2020.

References:

1. Deepak Khemani. *A First Course in Artificial Intelligence*. 1st Edition. 6th Reprint, 2018.
2. Munesh Chandra Trivedi. *A Classical Approach to Artificial Intelligence*. 2nd Edition. Khanna Publishers. 2018.

Catalogue prepared by	Dr. Sandeep Albert Mathias
Recommended by the Board of Studies on	BOS NO: SOCSE 2nd BOS held on 17/03/25
Date of Approval by the Academic Council	Academic Council Meeting No 21, Dated 17/03/25

Course Code: CSE1500	Course Title: Computational Thinking using Python Type of Course: ESC	L-T-P-C	2	0	2	3
Version No.	1.0					
Course Pre-requisites	Nil					
Anti-requisites	NIL					
Course Description	The course efficiently introduces fundamental ideas including conditionals, loops, functions, lists, strings, and tuples through some inspiring examples. It then discusses dynamic programming like handling exceptions and file usage. In terms of data structures, the course covers Python dictionaries, classes, and objects for constructing user-defined datatypes like linear and binary search.					
Course Object	The objective of the course is to familiarize the learners with the concepts of Computational Thinking using Python and attain Skill Development through Participative Learning techniques.					
Course Out Comes	On successful completion of the course the students shall be able to: 1) Describe algorithmic solutions for basic computing issues.. (Understand) 2) Explain data types and operators. (Understand) 3) Demonstrate control structures and Functions. (Apply) 4) Apply the data structures for the given data. (Apply) 5) Demonstrate the file operations. (Apply)					
Course Content:						
Module 1	Computational Thinking And Problem Solving	Assignment		Programming	6 Sessions	
Topics: Fundamentals of Computing– Identification of Computational Problems Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi						
Module 2	Datatypes, Expressions, Statements	Assignment		Programming	6 Sessions	
Topics: Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.						
Module 3	Control flow, Functions, Strings	Assignment		Programming	6 Sessions	
Topics: Conditionals: Boolean values and operators, conditional (if), alternative (if						

else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

Module 4	Lists, Tuples, Dictionaries	Assignment	Programming	6 Sessions

Topics:
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing- list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

Module 5	Files	Assignment	Programming	6 Sessions

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

Project work/Assignment:

1. Assignment 1 on (Module 1 and Module 2)
2. Assignment 2 on (Module 3 and Module 4 & 5)

Text Book

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021
2. Eric Matthes, Python Crash Course,: A Hands-On, Project-Based Introduction to Programming, 3rd Edition, 2023

References

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

Web Resources

W1. https://onlinecourses.nptel.ac.in/noc20_cs70/preview

Topics relevant to development of "Employability": Data structures using python.
Topics relevant to "PROFESSIONAL ETHICS": Naming and coding convention for simple programs using python.

PROGRAM CORE COURSES

Course Code: EEE2500	**Course Title:** Network Theory Type of Course: Professional Core & Theory only	L-T- P-C	3	1	0	4
Version No.	1.0					
Course Pre-requisites	MAT2301-Calculus and Differential Equation					
Anti-requisites	NIL					
Course Description	This Course aims at obtaining the solutions to problems in electrical networks using various network reduction techniques and theorems. The course is both conceptual and analytical in nature and uses the basic knowledge on mathematics to analyse electrical circuits.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Network Theory and attain Skill Development through Problem Solving methodologies					
Course Out Comes	On successful completion of the course the students shall be able to: 1] Describe various network reduction techniques to reduce the complexity of circuits 2] Apply various network theorems to electrical networks. 3] Examine the behaviour of electric circuits for DC and AC excitation. 4] Outline the parameters of two port network and relation between Voltage, current and power in poly phase circuits.					
Course Content:						
Module1	Module:1 Network Reduction Techniques:	Assignment	Quiz	9L+3T Sessions		
Topics: Types of electric circuit elements and sources, Source transformation, mesh analysis, Nodal analysis						
Module2	Module: 2 Network theorems:	Assignment	Simulation	12L+4T Sessions		
Topics: Statement of all Network Theorems, Explanation of Super position theorem, Thevenin's theorem, Maximum power transfer theorem and numerical examples on these theorems (DC &AC)						
Module3	Module:3TransientAnalysis and Resonance	Assignment	Programming/Simulation	12L+4T Sessions		
Topics: Initial conditions, transient analysis of RL, RC circuits, Laplace transforms of RL, RC circuits with step input, Concept of Resonance and frequency response for sinusoidal input.						
Module4	Module:4 Two port networks	Assignment	Quiz	12L+4T Sessions		
Topics: Introduction, Z parameters-parameters, ABCD parameters and h-parameters. Analysis of Poly						

Phase circuits: Voltage, Current and Power relations in a balanced Star band Delta connected load.
Targeted Application & Tools that can be used: Application Area is Electrical appliances used in residential properties, DC and AC circuits for Power electronic converters, Spark plug in automobiles, Battery Management system in Electric Vehicles. Professionally Used Software: Multisim, MATLAB Simulink
Textbooks 1. Ravish.R.Singh,"ElectricalNetworks",McgrawHillcompany,2009 2. Charles K Alexander and Matthew NO Sadiku" Fundamentals of Electric Circuits (4th) Edition
References 1. VanValkenberg,"NetworkAnalysis",PrenticeHall,1974.PHI 2. J.A.Edminister,"Theory and Problemsof ElectricCircuits",Schaum'sOutlineSeries,4thEdition. Online resources 1. https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=electric%20circuit%20analysis 2. https://www.tutorialspoint.com/network_theory/index.htm 3. https://nptel.ac.in/courses/108/105/108105159/ 4. CaseStudyhttps://www.scribd.com/document/420348012/Case-Study 5. E book: Electric Circuits: A Primer, Olivier, J. C , 2018 https://presiuniv.knimbus.com/user#/home
Topics relevant to "SKILL DEVELOPMENT": Network Reduction Techniques and Source transformation for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in Course Plan.

Catalogue prepared by	Mr. Bishakh Paul
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2021	Course Title: Digital Electronics Type of Course: Program Core Theory only	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 theoreticknowledge.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Digital Electronics and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING .					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Make use of the number systems and Boolean algebra concepts for digital circuits. CO2 Utilize various reduction techniques to simplify the digital circuits. CO3 Model the combinational logic circuits for arithmetic operators, data processors, and Programmable Gate Arrays. CO4 Construct the sequential logic circuits for registers, counters, and State Machines. CO5 Develop the HDL code of combinational and sequential circuits for realtime digital applications. CO6 Examine the digital circuits to validate and optimize the logical functions					
Course Content:						
Module 1	Fundamentals of Number systems- Boolean algebra and digital logic	Application Assignment	Data Analysis task		8classes	
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 Analysis task	15Classes

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]

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.):

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 DipayanBhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;KazuyukiMurase2010 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 relevant to "SKILL DEVELOPMENT": Adders, Multiplexers, Decoders / Encoders; Flip-Flops, Counters and Registers for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE2051	Course Title: Digital Electronics Lab Type of Course: Program Core	L-T-P-C	0	0	2	1
Version No.	1.0					
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 theoreticknowledge.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Digital Electronics and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING .					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Demonstrate the importance of Logic gates and Boolean laws in digital circuit design CO2 Develop the Small Scale Integrated Circuits for real-time Arithmetic operators CO3 Make use of Medium Scale Integrated Circuits for Digital Engineering applications CO4 Implement the sequential circuits for registers, memories and counters using physical ICs CO5 Examine the performance of combinational circuits using EDA tools CO6 Analyze the parameter characteristics of sequential circuits using EDA tools					
Course Content:						
List of LaboratoryTasks: 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

Text Book(s):

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

2. eBook1: Mano, M. Morris and Ciletti Michael D., *"Digital Design"*, Pearson Education.
3. {[PDF] Digital Design By M. Morris Mano, Michael D Ciletti Book Free Download
4. eBook2:Floyd "DIGITAL LOGIC DESIGN" fourth edition- ePub, eBook- [PDF] DIGITAL

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 DipayanBhadra;Tanvir Ahmed Tarique;Sultan Uddin Ahmed;Md. Shahjahan;KazuyukiMurase2010 13th International Conference on Computer and Information Technology (ICCIT)

3 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 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 relevant to "SKILL DEVELOPMENT": Adders, Multiplexers, Decoders / Encoders; Flip-Flops, Counters and Registers for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE2508	Course Title: Signal Processing Type of Course: Program Core-Theory	L-T-P-C	3	1	0	4
Version No.	1.0					
Course Pre-requisites	An understanding in basic concepts of electronic circuits and familiarity with discrete mathematics.					
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 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 signal processing. This course will teach the overview of signals and system, various transformation and filter design procedures. This course enhances student's abilities to follow future courses in Signal Processing Specialization like VLSI Signal Processing, Multimedia Signal Processing, Audio Signal Processing etc.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Explain the characteristics of signals, systems, and transforms including Fourier series, DTFT, and Z-transform properties. CO2 Illustrate the principles of DFT, circular convolution, and the advantages of FFT over direct DFT computation. CO3 Demonstrate the FFT of discrete sequences using Radix-2 DIT-FFT algorithms. CO4 Solve analog-to-digital IIR filter conversion using impulse invariance and bilinear transformation methods. CO5 Compare different windowing techniques (Rectangular, Hamming, Hanning) for FIR filter design. CO6 Analyze the differences between direct form, cascade, and parallel realizations of IIR filters.					
Course Content:						

Module 1	Overview of Signals and Systems	Assignment / Quiz	Memory Recall based Quizzes/ Problem Solving Tutorial	12 session
Overview and applications of Signal Processing-Advantage and Disadvantage of DSP- Sampling Reconstruction- Signal Definition- Classification of signals-signal operations- System Definition-Classification of System-Linear Time Invariant Systems-Convolution- Linear and Circular convolution - Fourier Series Representation-Discrete Time Fourier Series and its properties- Fourier Transform – Z Transform- properties -Analysis and Characterization of LTI systems.				
Module 2	Discrete Fourier Transform	Assignment / Quiz	Memory Recall based Quizzes/ Problem Solving Tutorial	12 session
Introduction and needs of Transformation -DTFT - DFT -Properties of DFT, Problems on DFT and IDFT- Fast Fourier Transform- Comparison of FFT with Direct evaluation of the DFT, Radix-2 FFT algorithms for the computation of DFT and IDFT- DIT- DIF				
Module 3	IIR Filter Design and Realizations	Assignment / Quiz	Memory Recall based Quizzes/ Problem Solving Tutorial	12 session
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	Assignment / Quiz	Memory Recall based Quizzes/ Problem Solving Tutorial	12 session
FIR filter design using windows (Rectangular/Hamming/ Hanning window), Frequency sampling method. FIR filter structures - direct form realizations - linear phase structure realizations.				
Module 5	Finite word length effects and Processor Fundamentals	Assignment / Quiz	Memory Recall based Quizzes/ Problem Solving Tutorial	12 session
Finite Word Length effects- Fixed point and floating point representation-Quantization – Signal scaling- Multi-rate signal processing-Down sampling- Upsampling- Overview of Digital Signal Processor-TMS320c50-Application of Digital Signal Processing				

Text Book(s):

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

References:

Reference Book(s):

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

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

1. Video lectures on Signals and Systems by Alan V Oppenheim

   Lecture 1
   https://www.youtube.com/watch?v=KJnAy6hzetw&list=PL41692B571DD0AF9B

   Lecture 2
   https://www.youtube.com/watch?v=6xaaeop7gJ8&list=PLADC1A1B7FA7FF7B6

   YouTube NPTEL video lectures signals and system:
   https://www.youtube.com/watch?v=7Z3LE5uM-6Y&list=PLbMVogVj5nJQQZbah2uRZIRZ_9kfoqZyx

2. Overview Basic Signal Representation
   http://users.ece.utexas.edu/~bevans/courses/realtime/lectures/midterm1.html
3. Introduction to FFT Digital Signal Processing Tutorial (tutorialspoint.com)
4. Filter Design and Realizations FOR DSP PRESENTATION (wustl.edu)
5. Introduction to Digital Signal Processing Course | MATLAB Helper ® - YouTube
6. Introduction to Signal Processing - YouTube

-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
Recommended by the Board of Studies on	
Date of Approval by the Academic	

Council	

Course Code: ECE2508	Course Title: Signal Processing Lab Type of Course: Program Core-Lab	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	An understanding in basic concepts of electronic circuits and familiarity with discrete mathematics.					
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 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 signal processing. This course will teach the overview of signals and system, various transformation and filter design procedures. This course enhances student's abilities to follow future courses in Signal Processing Specialization like VLSI Signal Processing, Multimedia Signal Processing, Audio Signal Processing etc.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: CO1. Classify signals and systems, and apply signal transformations. CO2. Implement and analyze DFT, IDFT, and FFT algorithms. CO3. Design and realize IIR and FIR filters. CO4. Apply finite word length effects and multi-rate signal processing.					
Course Content:						

List of Laboratory Task:

Experiment No. 1: Signal Classification and Operations

Level 1: Classification of different types of signals (periodic, aperiodic, deterministic, random) using MATLAB or Python.

Level 2: Performing basic signal operations such as time-shifting, scaling, and time-reversal on both continuous and discrete signals.

Experiment No. 2: Convolution in Linear Systems

Level 1: Implementing and computing the convolution of discrete-time signals using MATLAB or Python.

Level 2: Comparing results of convolution for continuous-time signals with computational tools and analyzing system behavior.

Experiment No. 3: Fourier Series Representation of Periodic Signals

Level 1: Computing the Fourier Series expansion of periodic signals using MATLAB or Python.

Level 2: Visualizing and analyzing the convergence of the Fourier Series for various truncations of the series.

Experiment No. 4: Fourier Transform of Continuous-Time Signals

Level 1: Calculating and visualizing the Fourier Transform of continuous-time signals like

exponential, sinusoidal, and rectangular signals.

Level 2: Analyzing the relationship between the time-domain and frequency-domain representations.

Experiment No. 5: Z-Transform and Its Properties

Level 1: Computing the Z-Transform of discrete-time signals using MATLAB or Python.

Level 2: Analyzing the region of convergence, poles, and zeros of the Z-Transform for various signals.

Experiment No. 6: Discrete Fourier Transform (DFT) and Inverse DFT (IDFT)

Level 1: Computing and visualizing the DFT and IDFT of discrete signals using MATLAB or Python.

Level 2: Comparing results with theoretical values and analyzing frequency-domain characteristics of the signals.

Experiment No. 7: Fast Fourier Transform (FFT) Implementation

Level 1: Implementing the Radix-2 FFT algorithm using MATLAB or Python.

Level 2: Comparing computational time and efficiency of FFT versus direct DFT computation.

Experiment No. 8: Frequency Resolution and Spectral Leakage

Level 1: Applying different window functions (e.g., Hanning, Hamming, Rectangular) to a signal and performing DFT.

Level 2: Observing and analyzing the impact of windowing on frequency resolution and spectral leakage.

Experiment No. 9: IIR Filter Design using Butterworth and Chebyshev Filters

Level 1: Designing analog low-pass Butterworth and Chebyshev filters using MATLAB.

Level 2: Converting the analog filters to digital filters using Impulse Invariance and Bilinear Transformation methods, and visualizing frequency responses.

Experiment No. 10: IIR Filter Realization (Direct Form and Cascade)

Level 1: Implementing IIR filters using different realizations (Direct Form I, Direct Form II) in MATLAB or Python.

Level 2: Analyzing the performance of IIR filter realizations in terms of stability, efficiency, and computational cost.

Text Book(s):

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

References:

Reference Book(s):

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

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

2. Video lectures on Signals and Systems by Alan V Oppenheim

Lecture 1
https://www.youtube.com/watch?v=KJnAy6hzetw&list=PL41692B571DD0AF9B

Lecture 2
https://www.youtube.com/watch?v=6xaaeop7gJ8&list=PLADC1A1B7FA7FF7B6

YouTube NPTEL video lectures signals and system:
https://www.youtube.com/watch?v=7Z3LE5uM-6Y&list=PLbMVogVj5nJQQZbah2uRZIRZ_9kfoqZyx

3 Overview Basic Signal Representation
http://users.ece.utexas.edu/~bevans/courses/realtime/lectures/midterm1.html

3. Introduction to FFT Digital Signal Processing Tutorial (tutorialspoint.com)
4 Filter Design and Realizations FOR DSP PRESENTATION (wustl.edu)
5 Introduction to Digital Signal Processing Course | MATLAB Helper ® - YouTube
6 Introduction to Signal Processing - YouTube

-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
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code: CSE2257</td><td colspan="3">Course Title: Computer Organization and Architecture
Type of Course: PCC</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8"></td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">This course introduces the core principles of computer architecture and organization from basic to intermediate level. This theory based course emphasizes on understanding the interaction between computer hardware and software. It equips the students with the intuition behind assembly-level instruction set architectures. It helps the students to interpret the operational concepts of computer technology as well as performance enhancement.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is to familiarize the learners with the concepts of Computer Organization and Architecture and attain Skill Development through Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of the course the students shall be able to:
1] Describe the basic components of a computer and their interconnections. [Remember]
2] Explain Instruction Set Architecture and Memory Unit [Understand]
3] Apply appropriate techniques to carry out selected arithmetic operations [Apply]
4] Explain the organization of memory and processor sub-system [Understand]</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>Basic Structure of Computer</td><td>Assignment</td><td>Data Analysis task</td><td colspan="5">12 Sessions</td></tr>
<tr><td colspan="9">Topics:
Computer Types, Functional Units, Basic Operational concepts, Bus Structures, Computer systems RISC & CISC, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. Arithmetic Operations on Signed numbers. Instructions and Instruction Sequencing, Instruction formats,
Memory Instructions.</td></tr>
<tr><td>Module 2</td><td>Instruction Set Architecture and Memory Unit</td><td>Assignment</td><td>Analysis, Data Collection</td><td colspan="5">12 Sessions</td></tr>
<tr><td colspan="9">Topics:
Instruction Set Architecture: Addressing Modes, Stacks and Subroutines.
Memory System: Memory Location and Addresses, Memory Operations, Semiconductor RAM Memories, Internal Organization of Memory chips, Cache memory mapping Techniques.</td></tr>
<tr><td>Module 3</td><td>Arithmetic And Input/output Design</td><td>Case Study</td><td>Data analysis task</td><td colspan="5">10 Sessions</td></tr>
<tr><td colspan="9">Topics:
Arithmetic: Carry lookahead Adder, Signed-Operand Multiplication, Integer Division, and Floating point operations.
Input/output Design: Accessing I/O Devices, I/O communication, Interrupt Hardware, Direct Memory Access, Buses, Interface Circuits</td></tr>
</table>

Module 4	BPU and Pipelining	Assignment	Analysis, Data Collection	11 Sessions

Topics:

Basic Processing Unit: Fundamental Concepts, Single Bus organization, Control sequence, Execution of a Complete Instruction, Multiple Bus Organization.
Pipelining: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Hazards.

Targeted Application & Tools that can be used:

Targeted employment sector is processor manufacturing and memory chip fabrication vendors like Intel, AMD, Motorola, NVidia, Samsung, Micron Technology, western Digital etc. Targeted job profiles include Memory circuit design and verification engineers, Physical system design engineer, System programmer, Fabrication engineer etc.

Tools:

Virtual Lab, IIT KGP
Tejas – Java Based Architectural Simulator, IIT Delhi

Project work/Assignment:

Each batch of students (self-selected batch mates – up to 4 in a batch) will be allocated case studies/assignments

Textbook(s):

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", Sixth Edition, McGraw-Hill Higher Education, 2023 reprint.
2. William Stallings, "Computer Organization & Architecture – Designing for Performance", 11th Edition, Pearson Education Inc., 2019.

References

1. David A. Patterson & John L. Hennessy, "Computer Organization and Design MIPS Edition- The Hardware/Software Interface", 6th Edition, Morgan Kaufmann, Elsevier Publications, November 2020.
2. Web References:
3. NPTEL Course on "Computer architecture and organization" IIT Kharagpur By Prof. Indranil Sengupta, Prof. Kamalika Datta. https://nptel.ac.in/courses/106105163
4. NPTEL Course on "Computer Organization", IIT Madras By Prof. S. Raman.
5. https://nptel.ac.in/courses/106106092
6. https://puniversity.informaticsglobal.com:2229/login.aspx

Topics relevant to "SKILL DEVELOPMENT": Generation of Computers, CISC and RISC processors, Bus Arbitration, Collaboration and Data collection for Term assignments and Case Studies for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

<table>
<tr><td>Course Code: ECE2510</td><td colspan="3">Course Title: Introduction to Fabrication Technology
Type of Course: Program Core</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">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.</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The purpose of this course is to enable the students to understand the 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.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is to familiarize the learners with the concepts of IC Fabrication Technology and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
1) Describe 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.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Crystal Growth</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td>12 Session</td></tr>
<tr><td colspan="9">Topics:
Introduction to Semiconductor Fabrication, Electronic-grade silicon, Czochralski crystal growth method, Crystal growth Theory, Crystal Structures and Grain boundaries, Crystal Structure of Silicon, Defects in crystals, Single and Polycrystalline Silicon. Clean room and Wafer Cleaning: Definition, Need of Clean Room</td></tr>
<tr><td>Module 2</td><td colspan="2">Oxidation and lithography</td><td>Assignment</td><td colspan="3">Theoretical Understanding</td><td>12 Session</td></tr>
<tr><td colspan="9">Topics:
Kinetics of Oxidation, Oxidation Rate Constants, Oxidation techniques and systems, Dry and Wet Oxidation, Overview of Lithography, Masks, optical lithography-optical resists, electron lithography-resists, mask generation. Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography. Etching: Anisotropy, Selectivity, Wet and Dry Etching, Plasma Etching, Reactive Ion Etching.</td></tr>
<tr><td>Module 3</td><td colspan="2">Diffusion and Thin Film Deposition</td><td>Assignment</td><td colspan="3">Theoretical Understanding</td><td>14 Session</td></tr>
<tr><td colspan="9">Topics:
Models of diffusion in solids, Successive Diffusion, Lateral Diffusion, Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Thermal evaporation, Resistive Evaporation, Physical vapour deposition, Chemical Vapor Deposition: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques. Introduction to packaging, Package types, Sputtering</td></tr>
<tr><td colspan="9">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, vFabLab</td></tr>
</table>

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.
5. BOSE - IC Fabrication Technology (2011, MC GRAW HILL INDIA)

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

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

E-content:

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

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

Catalogue prepared by	Dr Divya Prakash
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2560	Course Title: Introduction to Fabrication Technology Lab Type of Course: Program Core	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	VLSI Design, design and implementation of VLSI circuits for complex digital and analog systems, NMOS and CMOS fabrication steps, design for testability and design verification.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the basics of IC fabrication technology. This course aims to foster knowledge of Integrated circuit technology and fabrication techniques. This course introduces the various manufacturing methods and their underlying scientific principles in the context of technologies used in VLSI chip fabrication and Microcontrollers. This course also discusses the complexities and challenges associated with VLSI chip fabrication and different Microcontrollers. The course gives clear understanding about entire Chip fabrication.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of IC Fabrication Technology and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 5) Simulate basic micro fabrication processes such as thermal oxidation, photolithography, and etching to study their effects on wafer properties. 6) Model thin film deposition and planarization techniques to examine their impact on film characteristics and surface quality.					
Course Content:						

List of Laboratory Tasks:

Link: [vFabLab](https://vfablab.org)

Experiment 1: Thermal Oxidation

Description: Simulate the thermal oxidation process to grow silicon dioxide layers on silicon wafers. Understand the effects of temperature and time on oxide thickness.

Experiment 2: Photolithography

Description: Conduct a photolithography experiment to pattern features on a silicon wafer using masks and photoresist. Analyze how exposure and development affect pattern fidelity.

Experiment 3: Etching Processes- Wet Etching

Description: Perform wet etching simulations to remove specific layers from silicon wafers. Study the effects of etching time and chemical composition on etch rates.

Experiment 4: Etching Processes- Dry Etching

Description: Perform dry etching simulations to remove specific layers from silicon wafers. Study the effects of etching time and chemical composition on etch rates.

Experiment 5: Chemical Mechanical Polishing (CMP)

Description: Simulate the CMP process used for planarizing wafer surfaces. Evaluate how different polishing parameters influence surface roughness and material removal rates.

Experiment 6: Sputtering

Description: To understand the sputtering process used for thin film deposition, including the principles of magnetron sputtering, parameters affecting the deposition rate, and the resulting film characteristics.

Experiment 7: Thin Film Deposition

Description: Model various thin film deposition techniques, including Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD), to understand layer formation on wafers.

Experiment 8: Atomic Layer Deposition

Description: To understand the atomic layer deposition process, including the sequential use of gaseous precursors to create ultra-thin films on a substrate with precise thickness control.

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, vFabLab

Text Book

2. S.M. Sze, “VLSI technology”, Tata McGraw Hill, Second Edition, 2017.

Reference(s):

Reference Books

6. S. K. Ghandhi, “VLSI Fabrication Principles: Silicon and Gallium Arsenide”, John Wiley and Sons Inc., New York , 1983.
7. Plummer J. D., Deal M. D. and P. B. Griffin , “Silicon VLSI Technology: Fundamentals, Practice and Modeling” , Pearson/PHI, 2001.
8. Plummer J. D., Deal M. D. and P. B. Griffin , “Silicon VLSI Technology: Fundamentals, Practice and Modeling” , Pearson/PHI, 2001.
9. James Plummer, M. Deal and P.Griffin, “Silicon VLSI Technology”, Prentice Hall, Electronics and vLSI series, 2000.
10. BOSE - IC Fabrication Technology (2011, MC GRAW HILL INDIA)

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

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

E-content:

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

Topics relevant to “SKILL DEVELOPMENT”: Growth mechanics and kinetics, oxidation techniques and systems, packaging design considerations -for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr Divya Prakash
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code: ECE2521</td><td colspan="5">Course Title: Embedded System Design Using Microcontroller
Type of Course: Theory</td><td>L-T-P-C</td><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Version No.</td><td colspan="10">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="10">Basics of Electronics Devises, Logic Design, 8 bit/16 bit Microprocessor Architecture and Assembly Language Programing, Basics of C-Language, Memory types.</td></tr>
<tr><td>Anti-requisites</td><td colspan="10">NIL</td></tr>
<tr><td>Course Description</td><td colspan="10">The course provides insights into the fundamentals of microprocessor, microcontroller architecture and instruction set; knowledge for Embedded Systems Design. The course develops programming skills in both assembly language and middle level languages. Peripherals and their programming; Hardware and Software synchronization. Finally, embedded system design applications and some advanced topics will be covered. The comprehensive nature of the course covers assembly language programming using simulation tools.</td></tr>
<tr><td>Course Objective</td><td colspan="10">This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies</td></tr>
<tr><td>Course Outcomes</td><td colspan="10">On successful completion of this course the students shall be able to:
CO1: Distinguish architecture of various processors and microcontrollers
CO2: Summarize assembly language programming of Microcontroller.
CO3: Discuss the TIMER, PWM and UART unit
CO4: Apply interfacing of various peripherals to develop embedded applications.</td></tr>
<tr><td>Course Content:</td><td colspan="10"></td></tr>
<tr><td>Module 1</td><td colspan="3">Fundamentals of Embedded Systems</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">08 sessions</td></tr>
<tr><td colspan="11">Topics:
Embedded Systems: Introduction to Embedded Systems. RISC Design Philosophy. Design Philosophy, Embedded System Hardware, Embedded System Software

Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exemptions, Interrupts and Vector Table. Architecture Revisions, ARM Processor families, RISC-V.</td></tr>
<tr><td>Module 2</td><td colspan="3">Architecture and Programming</td><td>Assignment</td><td colspan="3">Programming and Simulation task / Memory Recall based Quizzes</td><td colspan="2">11 sessions</td></tr>
<tr><td colspan="11">Topics:

Introduction to Architecture. Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple</td></tr>
</table>

Assembly language program examples (without loops) to use these instructions.

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	Peripherals Interfacing	Assignment using Keil and Proteus	Programming Assignment	10 sessions

Topics:
Concepts of Input and Output Ports. Introduction to Embedded C: Conditional statements, loop statements. LPC 2148 Timer Unit, PWM Unit, UART, DAC, ADC

Module 4	Embedded system designing and applications	Assignment using Keil and Proteus	Interfacing and Programming Assignment	10 sessions

Topics:
Interfacing peripherals: Basics of Interfacing Switches, LEDs, Seven segment displays. Interfacing Stepper motors and DC motors. Embedded system applications examples and case studies.

Targeted Application & Tools that can be used:
Targeted Applications: Industry 4.0, Biomedical and Agricultural automation
Professionally Used Software: Keil Version 04/ Proteus

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 05 recent articles from the reputed national and international journal/ conferences will be given by students. They need to refer to tools like Scopus/ Google-Scholar and submit a report on their understanding of the assigned article in appropriate format.

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

Text Book(s):

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

Reference(s):
Reference Book(s):

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

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

4. Free online self-paced course :- https://bcourses.berkeley.edu.
5. Online notes :- https://mitpress.mit.edu/books/internet-things
6. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html
7. Online ppts :- https://www.upf.edu/pra/en/3376/22580
8. Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt
9. Presidency University Library Link

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

E-content:

1. Joseph Sifakis, " Embedded systems design - Scientific challenges and work directions 2009 Design, Automation & Test in Europe Conference & Exhibition https://ieeexplore.ieee.org/document/5090623
2. Gabor Karsai; Fabio Massacci; Leon Osterweil; Ina Schieferdecker," Evolving Embedded Systems", Computer , VOL. 43, issue.5 https://ieeexplore.ieee.org/document/5472888
3. Sachin P. Kamat," An eye on design: Effective embedded system software", IEEE Potentials, VOL. 29, issue.5 https://ieeexplore.ieee.org/document/5568178
4. Ahmed Abdallah; Eric M. Feron; Graham Hellestrand; Philip Koopman; Marilyn Wolf, " Hardware/Software Codesign of Aerospace and Automotive Systems", Proceedings of the IEEE , VOL. 98, issue.4 https://ieeexplore.ieee.org/document/5440056

Topics relevant to the: "FOUNDATION SKILLS", ARM Embedded Systems: Introduction to Embedded Systems. RISC Design Philosophy.

Topics related to development of "EMPLOYABILITY": Interfacing peripherals: Basics of Interfacing Switches, LEDs, Seven segment displays. Interfacing Stepper motors and DC motors.

Catalogue prepared by	Dr Anilloy Frank
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2571	Course Title: Embedded System Design Using Microcontroller Lab Type of Course: Lab	L-T-P-C	0	0	2	1
Version No.	1.0					
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 architecture of Embedded Systems Design. 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. The course develops programming skills in both assembly language and middle level languages. Peripherals and their programming; Hardware and Software synchronization. The comprehensive nature of the course covers assembly language programming using simulation tools.					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING Methodologies					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Demonstrate ALP and C programs of various processors and microcontrollers, the TIMER, PWM and UART unit CO2: Apply interfacing of various peripherals to develop embedded applications.					
Course Content:						

List of Laboratory Task:

Exp 01:- Level 01-WAP to find addition/Subtraction of two 32-bit numbers.
Level 02 -WAP to find average of 'n' 32-bit numbers.
Exp 02:- Level 01-WAP to find multiplication and Divison of two 32-bit numbers.
Level 02-WAP to transfer a block of word from Source to destination memory
Exp 03:- Level 01-WAP to find multiplication and Divison of two 32-bit numbers.
Level 02-WAP to transfer a block of word from Source to destination memory
Exp 04:- Level 01- WAP to implement hexadecimal addition/ subtraction.
Level 02- WAP to implement hexadecimal multiplication
Exp 05:- Level 01-CCS IDE with C-Programming
Level 02- Interfacing with basic Input / Output Devices LEDs
Exp 06:- Interfacing with basic Input / Output Devices switches
Exp 07:-Interfacing with basic Input / Output Devices PUSH Button
Exp 08:- Pulse Width Modulation (PWM) based Waveform Generation and Timing
Exp 09:- Interfacing of Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Converters

Exp 10:- Interfacing of Sensors (Temperature Sensors / Ultrasonic Sensors etc.) • Integrating multiple devices in a small project
Exp 11:- Interfacing of Displays (LCDs / seven-segment LEDs etc.)

Targeted Application & Tools that can be used:
Targeted Applications: Industry 4.0, Biomedical and Agricultural automation
Professionally Used Software: Keil Version 04/ Proteus

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 05 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):

3. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition
4. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.

Reference(s):
Reference Book(s):

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

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

13. Free online self-paced course :- https://bcourses.berkeley.edu.
14. Online notes :- https://mitpress.mit.edu/books/internet-things
15. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html
16. Online ppts :- https://www.upf.edu/pra/en/3376/22580
17. Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt
18. Presidency University Library Link

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

E-content:

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

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<tr><td colspan="2">Potentials, VOL. 29, issue.5
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8. Ahmed Abdallah; Eric M. Feron; Graham Hellestrand; Philip Koopman; Marilyn Wolf, " Hardware/Software Codesign of Aerospace and Automotive Systems", Proceedings of the IEEE , VOL. 98, issue.4
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<tr><td>Catalogue prepared by</td><td>Dr Anilloy Frank</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td></td></tr>
<tr><td>Date of Approval by the Academic Council</td><td></td></tr>
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Course Code: ECE3122	Course Title: Microelectronics Type of Course: General Basket Theory only		L-T-P-C	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Basic concepts of Digital and analog circuits.						
Anti-requisites	NIL						
Course Description	The purpose of this course is to provide students with a comprehensive understanding of the principles and applications of microelectronic devices and circuits. This course will cover the fundamental concepts and techniques necessary for the design, analysis, and fabrication of microelectronic systems.						
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.						
Course Outcomes	On successful completion of this course, the students shall be able to: CO1 Summarize the fundamental semiconductor physics for microelectronics circuits. CO2 Illustrate the characteristics of diode using mathematical models. CO3 Make Use of various diodes for real time analog circuits. CO4 Demonstrate the operations of transistor for amplifier and oscillator circuits. CO5 Examine the performance characteristics of transistors. CO6 Employ the CMOS technology in combinational and sequential device.						
Course Content:							
Module 1	MOSFETS	Quiz	Memory Recall based Quizzes	10 session			
Comparison of MOSFET and BJT, Device Structure and Physical Operation, V-I Characteristics, MOSFET Circuits at DC, Biasing in MOS amplifier Circuits, Small Signal Operation and Models, MOSFET as an amplifier and as a switch, biasing in MOS amplifier circuits, small signal operation modes, single stage MOS amplifiers. MOSFET internal capacitances and high-frequency modes, Frequency response of CS and SF amplifiers, Current mirrors and Current steering circuits, CMOS digital logic inverter, detection type MOSFET.							
Module 2	Opamp	Assignment / Quiz	Programming task	12 session			
Introduction to op-amp, block diagram and 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, Inverting and Non-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	Assignment	Memory Recall based Quizzes	12 session

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.

Module 4	Feedback amplifier and Oscillator using Op-amp	Assignment	Programming task	12 session

The General Feedback Structure, Some Properties of Negative Feedback, The Four Basic Feedback Topologies The Feedback Voltage Amplifier (Series—Shunt), The Feedback Transconductance Amplifier (Series—Series) The Feedback Transresistance Amplifier (Shunt—Shunt), The Feedback Current Amplifier (Shunt—Series), Determining the Loop Gain, The Stability Problem, Effect of Feedback on the Amplifier.

Oscillators Circuit: Positive Feedback and Barkhausen's Criterion, A Basic Oscillator, Wien Bridge Oscillator, RC Phase-shift oscillator, Colpitts and Hartley Oscillators, Power Amplifiers.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: ASICs, Signal conditioning circuits, Micro-Fabrication.

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

Project Work/Assignment:

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

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

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

Text Book(s):

5. Razavi, Behzad. Fundamentals of microelectronics. John Wiley & Sons, 2021.
6. Howe, R. T., and C. G. Sodini. Microelectronics: An Integrated Approach. Upper Saddle River, NJ: Prentice Hall, 1996. ISBN: 0135885183.

Reference(s):
Reference Book(s):

1. Fonstad, C. G. Microelectronic Devices and Circuits. New York, NY: McGraw-Hill, 1994. ISBN: 0070214964.

2. Sedra, A. S., and K. C. Smith. Microelectronic Circuits. 4th ed. New York, NY: Oxford University Press, 1998. ISBN: 0195116631.
3. Pierret, R. F. Semiconductor Device Fundamentals. Upper Saddle River, NJ: Prentice Hall, 1995. ISBN: 0201543931.

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

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

E-content:

6. The future of microelectronics. https://ieeexplore.ieee.org/document/658769
7. Technical and economical trends in microelectronics. https://ieeexplore.ieee.org/document/4430873
8. Microelectronics-journal. https://www.sciencedirect.com/journal/microelectronics-journal
9. Rymaszewski, Eugene J., Rao R. Tummala, and Toshihiko Watari. "Microelectronics packaging—An overview." *Microelectronics Packaging Handbook: Semiconductor Packaging* (1997): 3-128.

Topics related to development of "FOUNDATION": Mosfet, Opamp
Topics related to development of "EMPLOYABILITY": Amplifier, ADC, DAC, Multivibrator,

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2562	Course Title: Microelectronics Lab Type of Course: Program Core Theory only	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Basic concepts of Digital and analog circuits.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to provide students with a comprehensive understanding of the principles and applications of microelectronic devices and circuits. This course will cover the fundamental concepts and techniques necessary for the design, analysis, and fabrication of microelectronic systems.					
Course Objective	This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.					
Course Outcomes	On successful completion of this course, the students shall be able to: 1) Simulate MOSFET and op-amp-based circuits for amplification, switching, and waveform generation. 2) Implement linear and non-linear microelectronic circuits using simulation tools for signal processing applications.					
Course Content:						

List of Laboratory Tasks:

1. Simulate NMOS and PMOS Transfer Characteristics

Level 1: Simulate basic NMOS and PMOS circuits to observe output characteristics.

Level 2: Analyze threshold voltage and identify operating regions (cut-off, triode, saturation).

2. Design and Analyze a Common Source MOSFET Amplifier

Level 1: Construct and bias a common-source amplifier in simulation.

Level 2: Calculate voltage gain, and determine input/output resistance and frequency response.

3. Analyze Frequency Response of CS and Source Follower Amplifiers

Level 1: Simulate CS and source follower circuits using small signal AC analysis.

Level 2: Extract -3dB bandwidth, midband gain, and evaluate high-frequency limitations.

4. Simulate a CMOS Inverter and Evaluate Static Noise Margins

Level 1: Build a CMOS inverter using NMOS and PMOS transistors.

Level 2: Analyze VTC (Voltage Transfer Characteristics) and calculate noise margins.

5. Design Current Mirrors and Study Biasing Techniques

Level 1: Simulate a basic current mirror using MOSFETs.

Level 2: Study current replication accuracy and impact of channel-length modulation.

6. Implement an Instrumentation Amplifier Using Op-Amps

Level 1: Simulate a 3-opamp instrumentation amplifier configuration.

Level 2: Analyze differential gain, CMRR, and apply it to sensor signal conditioning.

7. Simulate Sample-and-Hold Circuits and OTA-based Design

Level 1: Build a sample-and-hold circuit using op-amp and switching elements.

Level 2: Analyze timing performance, droop rate, and simulate an OTA amplifier circuit.

8. Implement and Test a 3-bit R-2R DAC

Level 1: Simulate an R-2R DAC and apply digital inputs.

Level 2: Analyze output linearity, resolution, and voltage range.

9. Simulate a Successive Approximation Register (SAR) ADC

Level 1: Simulate a basic SAR ADC architecture using ideal components.

Level 2: Evaluate resolution, conversion time, and performance under noise.

10. Design and Perform Stability Analysis of a Negative Feedback Amplifier

Level 1: Construct an op-amp-based amplifier with feedback.

Level 2: Analyze loop gain, stability using Bode plots, and effects of feedback topology.

Targeted Application & Tools that can be used:
Targeted Applications: ASICs, Signal conditioning circuits, Micro-Fabrication.

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

Project Work/Assignment:

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

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

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

Text Book(s):

7. Razavi, Behzad. Fundamentals of microelectronics. John Wiley & Sons, 2021.
8. Howe, R. T., and C. G. Sodini. Microelectronics: An Integrated Approach. Upper Saddle River, NJ: Prentice Hall, 1996. ISBN: 0135885183.

Reference(s):

Reference Book(s):

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

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

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

E-content:

10. The future of microelectronics. https://ieeexplore.ieee.org/document/658769
11. Technical and economical trends in microelectronics. https://ieeexplore.ieee.org/document/4430873
12. Microelectronics-journal. https://www.sciencedirect.com/journal/microelectronics-journal
13. Rymaszewski, Eugene J., Rao R. Tummala, and Toshihiko Watari. "Microelectronics packaging—An overview." *Microelectronics Packaging Handbook: Semiconductor Packaging* (1997): 3-128.

Topics related to development of "FOUNDATION": Mosfet, Opamp
Topics related to development of "EMPLOYABILITY": Amplifier, ADC, DAC, Multivibrator,

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: EEE2504	Course Title: Control Systems Engineering Type of Course: Professional Core and Theory only	L-T-P- C	3	0	0	3
Version No.	3.0					
Course Pre-requisites	ECE2500: Signals and Systems					
Anti-requisites	NIL					
Course Description	The purpose of this course is to explore the importance of control system engineering and to develop the basic abilities of modelling and analyzing the control system. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming and simulation abilities through assignments					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Control Systems Engineering and attain Skill Development through Problem Solving methodologies					
Course Out Comes	On successful completion of the course the students shall be able to: 1] Interpret the transfer function for a variety of Electrical, Mechanical, Electromechanical systems using Signal Flow graphs. 2] Summarize the time domain specifications for various test input signals and stability conditions based on zeros and poles of transfer function. 3] Apply different stability analysis techniques in time domain and frequency domain to know the nature of stability of the system. 4] Explain about the controllability and observability of the given state model					
Course Content:						
Module 1	System Components and their representation	Assignment	Numerical	10 Sessions		
Topics: Introduction to control systems, mathematical models of physical systems-differential equations of physical systems, Mechanical systems, Electrical systems, Block diagrams and signal flow graphs.						
Module 2	Time Response Analysis, Controllers	Assignment, Quiz	Programming / Simulation	10 Sessions		
Topics: Unit step response of first and second order system, time response specifications, time response specifications of second order systems, steady state errors and error constants. P.PI and PID controllers						
Module 3	Stability Analysis and compensation techniques	Simulation	Programming	15 Sessions		
Topics: Concept of stability, Routh stability criterion, Root locus concept-rules for sketching root						

locus, Introduction, Frequency domain specifications -Bode diagrams, Stability Analysis from Bode Plots, Concept of relative stability. Introduction to Nyquist stability criteria. Lead, Lag, lead-lag compensating networks				
Module 4	State space model	Case study	Simulation	10 Sessions
Topics: Concept of State, State variables & State model, Concepts of controllability and observability. Introduction to Nonlinear systems				
Targeted Application & Tools that can be used: Control Systems are used in domestic applications, traffic light control, general industry, military and virtually every modern vehicle in the world, robotics. Modern industrial plants utilized robots for manufacturing temperature controls, pressure controls, speed controls, position controls, etc. In chemical process, control field is an area where automations play an important role. Professionally used tools: MATLAB/Simulink, Scilab, Octave.				
Project work/Assignment: Mention the Type of Project /Assignment proposed for this course				
Assignment: 1. Modeling of a second order system: Construct a Simulink diagram to calculate the response of the Mass-Spring system. The input force increases from 0 to 8 N at t = 1 s. The parameter values are M = 2 kg, K= 16 N/m, and B =4 N.s/m. 2. Using an m-file script, determine the close-loop transfer function of a given control system. 3. Identifying the system stability using Root locus technique by executing a programming code. 4. Open loop and closed loop time response of a second order system with different test inputs in MATLAB. 5. Using an m-file script, analyze the Frequency response of a system using Bode plot. 6. Implementation of controller (P/PI/PID) using aurdino.				
Text Book [1]. Nagrath I. J. and M. Gopal, Control Systems Engineering, New Age International (P) Ltd, 5th ed, 2007. [2]. K. Ogata, 'Modern Control Engineering', Pearson Education Asia / PHI, 4th Edition.				
References [1] Benjamin Kuo, 'Automatic Control Systems', PHI, 7th Edition. [2] Hasan Saeed, automatic control Systems with MATLAB programs, S K Kataria and sons, Latest ed. Online Learning Resources: 1. Ebook:https://presiuniv.knimbus.com/user#/home 2. Case study: https://people.disim.univaq.it/~costanzo.manes/Didattica_Teoria_dei_Sistemi/System_Theory_Web_Resources.html 3. https://nptel.ac.in/courses/107/106/107106081/				
Topics relevant to "SKILL DEVELOPMENT": Mathematical modelling, Stability analysis, Compensators Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.				

Catalogue prepared by	Dr Jisha L K
Recommended by the Board of Studies on	BoS No: 17th BoS held on 06/7/2023
Date of Approval by the Academic Council	21stAcademic Council meeting dated 06/09/2023

Course Code: ECE2522	Course Title: CMOS VLSI Design Type of Course: Program Core Theory	L- T- P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of VLSI Design-based systems. The course develops the knowledge of both hardware and software that leads to the design and implementation of both analogue VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of analog circuit design and layout using cadence virtuoso.					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using PARTICIPATIVE LEARNING techniques.					
Course Outcomes	CO1 Discuss the basic concepts of VLSI design. Understand CO2 Interpret the MOS transistor theory. Understand CO3 Evaluate the working of various CMOS Sub-circuits and Single Stage Amplifier. Understand CO4 Design the CMOS Amplifier Apply CO5 Analyze the different issues in layout, and floor Testing. Apply					
Course Content:						
Module 1	Device Physics	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions		
MOSFET Structure and Symbols, MOS I/V Characteristics, MOS Device Models: MOS Device Layout, MOS Device Capacitances, MOS Small-Signal Model, MOS SPICE models, NMOS Versus PMOS Devices, Long-Channel Versus Short-Channel Devices- Second-Order Effects. MOS Inverters-Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with N-type MOSFET Load. Introduction SiGe BICMOS Technology.						
Module 2	Sub-Circuits	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions		
CMOS Inverter-stick diagram & layout. Large signal analysis of MOS Devices. MOS Switch, MOS Diode/Active Resistor, Current Sinks and Sources, Current Mirrors Current and Voltage References,						
Module 3	Amplifiers	Assignment/ Quiz	Memory Recall based Quizzes	12 Sessions		
Single-Stage Amplifiers: Common Source, Common Drain and Common Drain Amplifier. Cascode Amplifier and Folder Cascode Amplifier, Design of Differential amplifier: large and Small Signal model, Slew Rate and OPAMP: Ideal vs Practical, Compensation of Opamp, Design of Single and 2 Stage opamp.						

Module 4	Design issues and trends	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions

Basics of data converters; Analog Testing, Floor Planning and Layout issues; Low Voltage and Low Power Circuits; Introduction to RF Electronics, Introduction to current mode VLSI design.

Targeted Application & Tools that can be used:

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

Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

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

Text Books:

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

Reference(s):

Reference Books

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

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

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

E-content:

1. Konar, Maitraiyee, Rashmi Sahu, and Sudip Kundu. "Improvement of the gain accuracy of the instrumentation amplifier using a very high gain operational amplifier." In *2019 Devices for Integrated Circuit (DevIC)*, pp. 408-412. IEEE, 2019. https://ieeexplore.ieee.org/abstract/document/8783414
2. Kundu, Sudip, and Pradip Mandal. "ISGP: Iterative sequential geometric programming for precise and robust CMOS analog circuit sizing." *Integration* 47, no. 4 (2014): 510-531. https://www.sciencedirect.com/science/article/pii/S0167926014000078
3. Singh, Geetanjali, Srikanta Pal, and Sudip Kundu. "A zero bias highly efficient active diode circuit for piezoelectric energy harvester." *International Journal of Nanoparticles* 14, no. 2-4 (2022): 106-120. https://www.inderscienceonline.com/doi/abs/10.1504/IJNP.2022.126377
4. Kundu, Sudip, and Pradip Mandal. "A generic and efficient modeling of phase margin of high performance CMOS OpAmps." In *Proceedings of the 2014 IEEE Students' Technology Symposium*, pp. 164-169. IEEE, 2014.

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<tr><td colspan="2">https://ieeexplore.ieee.org/abstract/document/6808040
5. Kumar, Vikash, Rishab Mehra, and Aminul Islam. "A 2.5 GHz Low Power, High-${Q} $, Reliable Design of Active Bandpass Filter." IEEE Transactions on Device and Materials Reliability 17, no. 1 (2017): 229-244. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7814293
5.Presidency University Library Link:-https://presiuniv.knimbus.com/user#/home</td></tr>
<tr><td colspan="2">Topics related to the development of “FOUNDATION SKILLS”: MOS Transistors,
Topics related to the development of “EMPLOYABILITY”: Design of Opamp</td></tr>
<tr><td>Catalogue prepared by</td><td>Dr Ashutosh Anand</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td></td></tr>
<tr><td>Date of Approval by the Academic Council</td><td></td></tr>
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Course Code: ECE2572	Course Title: CMOS VLSI Design Lab Type of Course: Program Core Lab	L- T- P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of VLSI Design-based systems. The course develops the knowledge of both hardware and software that leads to the design and implementation of both analogue VLSI circuits. The course emphasizes on CMOS technology, highlighting design methodology, testability, and design verification. The course also demonstrates the use of analog circuit design and layout using cadence virtuoso.					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	CO1 Analyse the MOS Transistor parameter. Analyse CO2 Analyse the designed Gates in Cadence Virtuoso. Analyse CO3 Create the schematic and symbol of CMOS amplifier. Analyse CO4 Analyze the different issues in layout, and floor Testing. Analyse					
Course Content:						

List of Laboratory Tasks:

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

1. Design a MOS transistor (nmos and pmos) using the cadence tool and obtain its Static Characteristics. Find the relationship between Current ID (Drain current) and Voltage VDS (Drain to Source voltage) for different values of Vgs (Gate to Source voltages). Find ID, Vgs and VDS? In which region the transistor is operating?
2. Design and simulate the Invertor Circuits, Create Symbol and Layout of the Invertor (All 3 Compulsory)
3. Design and Simulate the NAND gate, Create Symbol and layout of Nand gate. (All 3 Compulsory)
4. Design and simulate the NOR gate, Create Symbol and layout of NOR gate (All 3 are Compulsory)
5. Design the common source amplifier with given specifications, completing the design flow mentioned below: (a) Draw the schematic and symbol and verify the

following: DC Analysis, AC Analysis Transient Analysis (b) Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the Design.

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

(Optional Experiments)

Targeted Application & Tools that can be used:
Targeted Applications: Design of different VLSI Circuits and Subcircuits for industrial applications
Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

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

Text Books:

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

Reference(s):
Reference Books

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

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

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

E-content:

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

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

Catalogue prepared by	Dr Ashutosh Anand
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2514	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.):

1. Lecture videos for design for testability: https://onlinecourses.nptel.ac.in/noc20_ee76
2. PPT on Design for Testability, Link : https://eecs.ceas.uc.edu/~jonewb/DFTnew.pdf
3. https://www.youtube.com/watch?v=MgCFUO2BrkQ
4. https://www.youtube.com/watch?v=MEaMm423t0w&list=PLZjlBaHNchvOFBWBAtAP9exwQgYpKqsO4
5. https://www.geeksforgeeks.org/design-for-testability-dft-in-software-testing/
6. https://web.stanford.edu/class/archive/ee/ee371/ee371.1066/lectures/lect_14.2up.pdf
7. 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	BOS NO: 15th BOS held on 28/07/2022

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

Course Code: ECE3412	Course Title: Mixed Signal Circuit Design Type of Course: VLSI Basket Theory	L- T- P- C	3	0	0	3
Version No.	1.0					
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	The objective of the course is to familiarize the learners with the concepts of Mixed Signal Circuit Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
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.

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 relevant to "SKILL DEVELOPMENT": Phase locked loops, Nyquist rate D/A converters, Nyquist rate A/D Converters, Oversampling Converters - for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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. 16th , Dated 23/10/2021

Course Code: ECE2516	Course Title: VLSI Design Verification Type of Course: Theory only		L- T-P- C	3	0	0	3
Version No.	1.0					
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 understanding of verification methodologies for digital VLSI circuits and systems. It covers the complete VLSI design verification flow, including functional, timing, formal, and physical verification techniques. Students will explore simulation-based verification, the Universal Verification Methodology (UVM), and the use of SystemVerilog for writing effective testbenches. The course also delves into formal verification methods, such as equivalence checking and property checking, as well as coverage-driven verification to ensure high-quality verification processes. Additionally, it emphasizes automation in verification using scripting languages and tools like Python and TCL, along with hands-on experience in using industry-standard verification tools like VCS, ModelSim, and Questa. Finally, the course addresses low-power verification, mixed-signal verification, and timing analysis, providing a comprehensive foundation for tackling complex verification challenges in VLSI design.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of design for testability and attain EMPLOYABILITY SKILLS by using PARTICIPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: 1. Interpret the concepts of testing which can help to design a better yield in IC design. 2. Discuss the generation of test patterns. 3. Analyze the various test generation methods 4. Summarize the BIST techniques for improving testability						
Course Content:							
Module 1	Introduction to VLSI Design and Verification	Assignment/Quizzes	Memory Recall based Quizzes	12 Sessions			

Topics:

Introduction to VLSI design flow: specification, synthesis, verification, testing; CMOS technology, logic gates, ASIC vs FPGA design.

Importance of verification in VLSI design, types of verification: Functional, Timing, Formal, Physical; Overview of verification languages (SystemVerilog, Verilog, VHDL) and verification tools.

Functional verification techniques: Writing RTL and gate-level testbenches, simulation-based verification, UVM (Universal Verification Methodology) introduction, assertions in functional verification.

Simulation flow: Compile, elaborate, run simulations; Debugging simulation results, coverage analysis, and functional coverage in VLSI design verification.

Module 2	Advanced Verification Methodologies	Assignment	Simulation and analysis task	11 Sessions

Topics:

Formal verification methods: Equivalence checking, model checking, property checking; Formal verification tools.

Universal Verification Methodology (UVM): UVM components - Environment, Testbench, Sequencer, Driver, Monitor, Scoreboard; Randomization, constraints in UVM.

Coverage-driven verification: Types of coverage: code, functional, toggle; Coverage-driven tools (VCS, Questa); Coverage analysis and improvement.

Module 3	Verification Tools and Automation	Assignment/Quizzes	Design Analysis	11 Sessions

Topics:

Writing testbenches in SystemVerilog: Random stimulus generation, SystemVerilog Assertions (SVA), Best practices for reusable testbenches.

Automation in VLSI verification: Scripting using Python, TCL; Continuous Integration (CI), version control, error reporting in automated flows.

Overview of verification tools: ModelSim, VCS, Questa; Simulation setup, running simulations, debugging techniques using tools.

Module 4	Advanced Topics and Case Studies	Assignment/Project	Data Analysis	11 Sessions

Topics:

Low power verification: Power estimation tools, writing power-aware testbenches, Mixed-signal verification: Analog and digital interactions, tools (Verilog-AMS, SystemVerilog).

Timing and performance verification: Static timing analysis (STA), setup/hold violations, clock domain crossing; Performance verification for high-speed designs.

FPGA and ASIC verification methodologies: FPGA verification tools (Xilinx Vivado, Altera Quartus); ASIC/FPGA prototyping, verification flow.

Case studies and projects: Developing and verifying VLSI designs, real-world VLSI verification projects, final project presentations.

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):

Z.Navabi, "*Digital System Test and Testable Design*", Springer, 2011.

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

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

1. Lecture videos for design for testability:

https://onlinecourses.nptel.ac.in/noc20_ee76

2. PPT on Design for Testability, Link : https://eecs.ceas.uc.edu/~jonewb/DFTnew.pdf
3. https://www.youtube.com/watch?v=MgCFUO2BrkQ
4. https://www.youtube.com/watch?v=MEaMm423t0w&list=PLZjlBaHNchvOFBWBAtAP9exwQgYpKqsO4
5. https://www.geeksforgeeks.org/design-for-testability-dft-in-software-testing/
6. https://web.stanford.edu/class/archive/ee/ee371/ee371.1066/lectures/lect_14.2up.pdf

E-Content

1. Bukovjan, Peter, Meryem Marzouki, and Walid Maroufi. "Design for testability reuse in synthesis for testability." *Proceedings. XII Symposium on Integrated Circuits and Systems Design (Cat. No. PR00387)*. IEEE, 1999.

2. Williams, Thomas W. "Design for Testability: The Path to Deep Submicron." *14th Asian Test Symposium (ATS'05)*. IEEE, 2005.

3. Williams, Thomas W. "Design for testability: today and in the future." *VLSI Design, International Conference on*. IEEE Computer Society, 1997.

4. Williams, Thomas W., and Kenneth P. Parker. "Design for testability—A survey." *Proceedings of the IEEE* 71.1 (1983): 98-112.

5.Ghosh, Indradeep, Niraj K. Jha, and Sujit Dey. "A low overhead design for testability and test generation technique for core-based systems-on-a-chip." *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* 18.11 (1999): 1661-1676.

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

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2566	Course Title: VLSI Design Verification Lab Type of Course: Program Core Lab	L- T- P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Analog electronics, Linear Integrated Circuits, Network Theory.					
Anti-requisites	NIL					
Course Description	This course provides an in-depth understanding of verification methodologies for digital VLSI circuits and systems. It covers the complete VLSI design verification flow, including functional, timing, formal, and physical verification techniques. Students will explore simulation-based verification, the Universal Verification Methodology (UVM), and the use of SystemVerilog for writing effective testbenches. The course also delves into formal verification methods, such as equivalence checking and property checking, as well as coverage-driven verification to ensure high-quality verification processes. Additionally, it emphasizes automation in verification using scripting languages and tools like Python and TCL, along with hands-on experience in using industry-standard verification tools like VCS, ModelSim, and Questa. Finally, the course addresses low-power verification, mixed-signal verification, and timing analysis, providing a comprehensive foundation for tackling complex verification challenges in VLSI design.					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Apply verification methodologies to assess the functionality of digital VLSI circuits. Apply CO2: Develop and simulate testbenches in SystemVerilog for combinational and sequential circuits. Create CO3: Implement UVM-based testbenches for scalable and reusable verification environments. Create CO4: Analyze and apply formal verification techniques such as equivalence checking and property checking to ensure design correctness. Analyze					
Course Content:						

List of Laboratory Tasks:

Experiment No. 1: Introduction to VLSI Design Flow and Simulation
Level 1: Performing RTL simulation of a simple combinational circuit (e.g., adder or multiplexer) using Verilog/SystemVerilog.
Level 2: Verifying the functionality of the design and debugging simulation results using a waveform viewer.

Experiment No. 2: Writing Testbenches in SystemVerilog
Level 1: Writing a basic testbench for a combinational design (e.g., AND gate, OR gate) in SystemVerilog.
Level 2: Implementing assertions in the testbench to check for functional correctness and generating a coverage report.

Experiment No. 3: Introduction to UVM (Universal Verification Methodology)
Level 1: Developing a simple UVM-based testbench for a small digital circuit (e.g., 2-bit counter).
Level 2: Creating UVM components such as environment, testbench, sequencer, driver, and monitor, and running the simulation to verify functionality.

Experiment No. 4: Coverage Analysis in Simulation
Level 1: Running functional verification of a digital circuit and enabling coverage analysis.
Level 2: Analyzing code, functional, and toggle coverage reports to ensure the design is adequately tested.

Experiment No. 5: Formal Verification Using Equivalence Checking
Level 1: Performing equivalence checking between RTL and gate-level designs using formal verification tools.
Level 2: Analyzing the equivalence results to identify any mismatches between the designs and resolving issues.

Experiment No. 6: Introduction to Scripting for Verification Automation
Level 1: Writing a Python or TCL script to automate the simulation process, including setting up the environment and running tests.
Level 2: Automating the extraction of simulation results and generating a report to summarize the test outcomes.

Experiment No. 7: Timing Analysis and Static Timing Verification
Level 1: Performing static timing analysis (STA) on a simple digital circuit and checking for timing violations such as setup and hold violations.
Level 2: Interpreting the STA reports and addressing timing violations by adjusting the design parameters.

Experiment No. 8: Low Power Verification Techniques
Level 1: Simulating a low-power design and verifying the power consumption using a power estimation tool.
Level 2: Analyzing the design's power profile and applying techniques like clock gating and power-aware simulation to meet power constraints.

Experiment No. 9: Mixed-Signal Verification Using Verilog-AMS
Level 1: Developing a mixed-signal design that includes both analog and digital components (e.g., a digital-to-analog converter).
Level 2: Verifying the interaction between the analog and digital parts of the design using Verilog-AMS and analyzing simulation results.

Experiment No. 10: FPGA Design Verification
Level 1: Implementing and simulating a simple FPGA design (e.g., LED blink) using Xilinx Vivado or Altera Quartus.
Level 2: Verifying the FPGA design on hardware by synthesizing it and testing it on the FPGA development board.

Targeted Application & Tools that can be used:
Targeted Applications: Design of different VLSI Circuits and Subcircuits for industrial applications
Professionally Used Software: Cadence Virtuoso

Project work/Assignment:

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

Text Books:

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

Reference(s):

Reference Books

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

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

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

E-content:

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

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

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2517	Course Title: Communication Systems Type of Course: Theory only	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basics of analog and digital circuit design, binary operations in digital electronics, basic concept of signals and systems to perform operations on signals, elementary engineering mathematics					
Anti-requisites	NIL					
Course Description	The course deals with the importance and applications of communication engineering for both analog and digital signals, emphasizing on audio, video and image transmission & reception. The course is conceptual and application oriented. This course acts as a foundation for the future courses in communication domain like mobile and wireless communication, data communication and computer networks, satellite communication and advanced internet-of-things					
Course Objective	The objective of the course is to familiarize the learners with the concepts of design for testability and attain EMPLOYABILITY SKILLS by using PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Explain the fundamental concepts and methods of amplitude modulation and demodulation characteristics. CO2 Solve performance parameters such as modulation index, bandwidth and total power in analog communication systems using amplitude modulation and demodulation techniques. CO3 Solve performance parameters such as frequency deviation, bandwidth in communication systems using frequency modulation and demodulation methods to generate and detect FM signals. CO4 Apply digital modulation and demodulation processes to solve problems in digital communication systems. CO5 Describe the generation, properties, and applications of pseudonoise sequences and spread spectrum techniques in communication systems. CO6 Analyze the performance and applications of spread spectrum techniques and pseudo-noise sequences in digital communication systems.					
Course Content:						
Module 1	Introduction to Communication Engineering	Assignment	Simulation task		**12classes**	
Topics: Introduction: Elements of communication systems, modulation methods and its requirements, amplitude modulation & demodulation: DSB-FC (AM) modulation & its demodulation, generation of AM signals, sideband and carrier power of AM, double sideband suppressed carrier (DSB-SC) modulation & its demodulation, single sideband (SSB) transmission, generation of SSB signals, Comparison of various amplitude modulation techniques, illustrative numerical problems.						
Module 2	Angle modulation and	Case Study	Simulation		**12 classes**	

	demodulation		task.	
Topics: Concept of instantaneous frequency, generalized concept of angle modulation, bandwidth of angle modulated waves – Narrow band frequency modulation (NBFM) and Wide band FM (WBFM), generation of FM waves – indirect method and direct method. demodulation of FM signals, illustrative numerical problems.				
Module 3	Digital Modulation Techniques	Assignment	Simulation task :	**12 classes**
Topics: Block diagram of digital communication system, sampling theorem, practical aspects of sampling and signal recovery, pulse modulation, TDM, PCM and DM concepts, , ISI, Nyquist's criterion for distortion less transmission, illustrative numerical problems, digital modulation formats, coherent and non-coherent binary modulation techniques and waveform study.				
Module 4	Spread Spectrum Modulation and Detection & Estimation	Assignment	Simulation task:.	**12 classes**
Topics: Pseudo noise sequences, notion of spread spectrum, direct sequence spread spectrum, frequency hop spread spectrum, applications, probability of error (statement only), some applications of DS Spread spectrum signals, generation of PN sequences, illustrative numerical problems.				
Targeted Application & Tools that can be used: Application Area is transmission and reception of electrical signals, data, voice, image, video, text, scanned documents etc. between the two places through wired or wireless communication using communication engineering components or systems. Professionally Used Hardware/Software: DSP processor/Arduino/Raspberry PiLTSpice/MATLAB/SIMULINK				
Text Book(s): 1. Simon Haykin, "Communication Systems", John Wiley Publication, 2009, 5th Edition. 2. B.P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press 2011, 4th Edition.				
Reference(s): Reference Book(s): 1. B. Sklar, "Digital Communication: Fundamentals and Applications", Pearson Edition, 2nd Edition. 2. Sam Shanmugam, "Digital & Analog Communication K.", John Wiley Publication, 2nd Edition. 3. LT Spice/ MATLAB/SIMULINK software reference manual and for hardware appropriate kit reference manuals, experiments in communication engineering reference manual and data sheets. Online Resources (e-books, notes, ppts, video lectures etc.): 1. MIT OPEN COURSE:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/ 2. MIT PRINCIPLES OF DIGITAL COMMUNICATIONS:https://ocw.mit.edu/courses/electrical-engineering-and-computer-				

science/6-450-principles-of-digital-communications-i-fall-2006/video-lectures/lecture-1-introduction/

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

E-content:

1. L. S. Schwartz, "Recent developments in digital communications," in Electrical Engineering, vol. 82, no. 6, pp. 415-418, June 1963, doi: 10.1109/EE.1963.6541408. https://ieeexplore.ieee.org/document/6541408
2. M. A. Ben Farah, A. Kachouri and M. Samet, "Design of secure digital communication systems using DCSK chaotic modulation," International Conference on Design and Test of Integrated Systems in Nanoscale Technology, 2006. DTIS 2006., 2006, pp. 200-204, doi: 10.1109/DTIS.2006.1708656. https://ieeexplore.ieee.org/document/1708656
3. Gustavo P. Cainelli, Lisa Underberg, Lutz Rauchhaupt, Carlos E. Pereira, Asset administration shell submodel for wireless communication system., IFAC-PapersOnLine, Volume 55, Issue 2, 2022, Pages 120-125, ISSN 2405-8963, https://doi.org/10.1016/j.ifacol.2022.04.180.
4. Aleksandra Tutueva, Lazaros Moysis, Vyacheslav Rybin, Alexander Zubarev, Christos Volos, Denis Butusov, Adaptive symmetry control in secure communication systems, Chaos, Solitons & Fractals, Volume 159, 2022, 112181, ISSN 0960-0779. https://doi.org/10.1016/j.chaos.2022.112181.

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

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

Text Book(s):

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

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

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the	

Academic Council	

Course Code: ECE2567	Course Title: Communication Systems Lab Type of Course: Lab only	L- T-P- C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	Basics of analog and digital circuit design, binary operations in digital electronics, basic concept of signals and systems to perform operations on signals, elementary engineering mathematics					
Anti-requisites	NIL					
Course Description	The course deals with the importance and applications of communication engineering for both analog and digital signals, emphasizing on audio, video and image transmission & reception. The course is conceptual and application oriented. This course acts as a foundation for the future courses in communication domain like mobile and wireless communication, data communication and computer networks, satellite communication and advanced internet-of-things					
Course Objective	The objective of the course is to familiarize the learners with the concepts of design for testability and attain EMPLOYABILITY SKILLS by using PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Apply the principles of analog modulation techniques through hardware implementation and software simulation of Amplitude Modulation (AM), AM-DSB-SC, and AM-SSB-SC modulation and demodulation. CO2 Implement frequency modulation and demodulation principles through hardware and software simulation. CO3 Implement digital modulation and demodulation techniques for Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK) using hardware and simulation tools. CO4 Develop hardware and simulation models of multiplexing and sampling systems, including Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM) with DSB-SC, and Sampling & Reconstruction circuits. CO5 Demonstrate analog and digital pulse modulation techniques through hardware implementation and software simulation of Pulse Amplitude Modulation (PAM), Pulse Code Modulation (PCM), and Delta Modulation (DM)					
Course Content:						
List of Lab Tasks: Experiment N0 1:						

Level1: Implementation of general amplitude modulation and demodulation.

Level2: Implementation of general AM using the MATLAB/SIMULINK and study the output by varying the depth of modulation.

Experiment N0 2:

Level1: Study of AM-DSBSC and SSB-SC modulation and demodulation.

Level2: Implementation and generation of AM-DSBSC and SSB-SC modulation in MATLAB/SIMULINK and study of waveforms.

Experiment N0 3:

Level1: Study of frequency modulation and demodulation.

Level2: Implementation and generation of FM and PM modulation in MATLAB/SIMULINK and study of waveforms .

Experiment N0 4:

Level1: Simulate appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.

Level2: Rig up the appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment N0 5:

Level1: Implementation of sampling circuit to convert given analog signal into its samples with sampling frequency 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 6:

Level1: Simulate the appropriate quantizer circuit to replace the samples of analog signal into its nearest value using LT spice/MATLAB simulation tool

Level2: Rig up the appropriate quantizer circuit to replace the samples of analog signal into its nearest value using analog and/or digital hardware components.

Experiment N0 7:

Level1: Implementation of suitable encoder circuit to represent binary data for the quantized samples using LT spice/MATLAB simulation tool

Level2: Construct suitable encoder circuit to represent binary data for the quantized samples using analog and/or digital hardware components.

Experiment N0 8:

Level1:Simulate appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.

Level2: Rig up the appropriate parallel to serial converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment No. 9:

Level1: Simulate appropriate serial to parallel converter for the encoded binary bits to obtain serial binary data using LT spice/MATLAB simulation tool.

Level2: Rig up the appropriate serial to parallel converter for the encoded binary bits to obtain serial binary data using analog and/or digital hardware components.

Experiment No. 10:

Level1: Implementation of suitable decoder circuit to represent binary data for the quantized samples using LT spice/MATLAB simulation tool

Level2:Construct suitable decoder circuit to represent binary data for the quantized samples using analog and/or digital hardware components.

Experiment No. 11:

Level1:Implementation of reconstruction low pass filter to recover analog signal using LT spice/MATLAB simulation tool.

Level2: Carry out the reconstruction low pass filter circuit to recover analog signal using analog and/or digital hardware components.

Experiment No. 12:

Level1: Integration of all the experiments from 1 to 11, for the demonstration of pulse code modulation and demodulation using LT spice/MATLAB simulation tool.

Level2: Integration of all the experiments from 1 to 11, for the demonstration of pulse code modulation and demodulation for the given analog signal using analog and/or digital hardware components. Use co-axial or telephone cable as wired channel to establish communication between modulator and demodulator.

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

Text Book(s):

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

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

Reference(s):
Reference Book(s):

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

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

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

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

6. MIT OPEN COURSE:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/
7. 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/
8. 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/
9. 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/
10. Presidency Library Link:-https://presiuniv.knimbus.com/user#/home

E-content:

5. 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
6. 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
7. Gustavo P. Cainelli, Lisa Underberg, Lutz Rauchhaupt, Carlos E. Pereira, Asset administration shell submodel for wireless communication system., IFAC-PapersOnLine, Volume 55, Issue 2, 2022, Pages 120-125, ISSN 2405-8963, https://doi.org/10.1016/j.ifacol.2022.04.180.
8. Aleksandra Tutueva, Lazaros Moysis, Vyacheslav Rybin, Alexander Zubarev, Christos Volos, Denis Butusov, Adaptive symmetry control in secure communication systems, Chaos, Solitons & Fractals, Volume 159, 2022, 112181, ISSN 0960-0779. https://doi.org/10.1016/j.chaos.2022.112181.

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

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

Text Book(s):

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

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

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2519	Course Title: Physical Design and Automation Type of Course: Program Core- Theory	L-T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using real time algorithms used in VLSI industry.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Describe various graph algorithms. 2. Define computational complexity of different physical design algorithms. 3. Employ various algorithms for Partitioning, Placement and Floor planning. 4. Illustrate different types of routing algorithms.					
Course Content:						
Module 1	Design automation tools	Quiz	Memory Recall based Quizzes	10 classes		
Topics: VLSI design automation tools- algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools.						
Module 2	Layout compaction, Placement and Partitioning	Assignment	Design Analysis	9 classes		

Topics:
Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.

Module 3	Floor planning and Routing	Assignment	Design Analysis	9 classes

Topics:
Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

Module 4	Logic Synthesis & High Level Synthesis	Assignment	Programming and simulation	9 classes

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

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

Project work/Assignment:

Project Assignment:

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

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

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

Text Book(s):

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

Reference(s):

1. Stephen Trimberger, "Introduction to CAD for VLSI", Kluwer Academic publisher, 2002.
2. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, 2nd edition.

3. G. Hachtel and F. Somenzi, "Logic Synthesis and Verification Algorithms", Kluwer, 1998. 3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers; 3rd ed., 1999.

Online and Web resource (s):

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

E-Content:

1. H. Martin Bucker and Christian Sohr Bucker "Reformulating a Breadth-First Search Algorithm on an Undirected Graph in the Language of Linear Algebra" in IEEE 2014 International Conference on Mathematics and Computers in Sciences and in Industry, 33–35. doi:10.1109/MCSI.2014.40 https://ieeexplore.ieee.org/abstract/document/7046157
2. Farnaz Towhidi, Arash Habibi Lashkari "Binary Decision Diagram (BDD)" in IEEE 2009 International conference on future computer and communication, 03-05 April 2009, doi:10.1109/ICFCC.2009.31 https://ieeexplore.ieee.org/abstract/document/5189833.
3. Archana K Rajan, Deepika Bhaiya "VLSI partitioning using parallel kernighan lin algorithm" in IEEE 2017 International Conference on Communication and Signal Processing (ICCSP)-CHENNAI, India (2017.4.6-2017.4.8)doi:10.1109/ICCSP.2017.8286727 https://ieeexplore.ieee.org/abstract/document/8286727.
4. Groeneveld R "Physical design challenges for billion transistor chips" in IEEE International Conference on Computer Design-Freiberg, Germany(16-18 Sept. 2002), 78–83. doi:10.1109/ICCD.2002.1106751. https://ieeexplore.ieee.org/abstract/document/1106751.

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

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

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

Course Code: ECE2569	Course Title: Physical Design and Automation Laboratory Type of Course: Program Core Theory Only	L-T- P- C	0	0	2	4
Version No.	2.0					
Course Pre-requisites	Basic concepts of Digital Electronics, VLSI design flow, VLSI circuits implementation for complex digital and analog systems.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students, the fundamentals techniques and algorithms used in Computer-Aided Design tools. Modelling, analysis of digital VLSI systems, computer-aided design (CAD) algorithms for various design specifications will be covered. The course develops design skills and could enable students to apply algorithms related to physical design of VLSI circuits.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using real time algorithms used in VLSI industry.					
Course Outcomes	On successful completion of this course the students shall be able to: 5. Describe various graph algorithms. 6. Define computational complexity of different physical design algorithms. 7. Employ various algorithms for Partitioning, Placement and Floor planning. 8. Illustrate different types of routing algorithms.					
Course Content:						
List of Laboratory Tasks: Experiment No. 1: Study of Resistors, Measuring instruments and DC Power Supply. Level 1: Identification of resistor values from color bands and verification with Multimeter. Level 2: Connecting a resistive circuit to a DC Power Supply and observing the input and output values using Voltmeters, Ammeters and hence calculate resistance values.						

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

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

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

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

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

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

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

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

Targeted Application & Tools that can be used:

Application Areas are aspects of Computational Circuit Analysis, VLSI Circuit Analysis, Timing Verification and Optimization, Design and Layout Generation.

Professionally Used Software: VHDL compiler and simulator, logic synthesis tools, and automatic place and route tools available with Vivado design suit.

Project work/Assignment:

Project Assignment:

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

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

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

Text Book(s):

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

Reference(s):

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

Online and Web resource (s):

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

E-Content:

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

https://ieeexplore.ieee.org/abstract/document/8286727.

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

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

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

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

<table>
<tr><td>Course Code:
ECE2553</td><td colspan="4">Course Title: Digital VLSI Design
Type of Course: Program Core, Theory only</td><td>L- T-P- C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">Low Power VLSI Design, Foundations for VLSI Design</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">The purpose of this course is to enable the students 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.</td></tr>
<tr><td>Course Objective</td><td colspan="9">This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using open source Design Tools.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">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.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td colspan="3">Introduction and Methodology</td><td>Quiz</td><td colspan="3">Memory Recall based Quiz</td><td colspan="2">12 Session</td></tr>
<tr><td colspan="10">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</td></tr>
</table>

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:

1. Students will be made into group and given the programming assignment at the end of each module. Students need to use VERILOG for these assignments.

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.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format Presidency University Library Link .
3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.

Text Book(s):

T1 Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010
T2 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.

Reference(s):

Reference Book(s):

1. Ming-Bo Lin, "Digital System Designs and Practices: Using Verilog HDL and FPGAs", Wiley, 2008
2. Charles Roth, Lizy K. John, Byeong Kil Lee, "Digital Systems Design Using Verilog", Cengage, 1st Edition.
3. Donald E. Thomas, Philip R Moorby, 'TheVerilog Hardware Description Language", Springer, Fifth edition.
4. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition.
5. Donald E. Thomas, Philip R Moorby, 'The Verilog Hardware Description Language", Springer Science+Business Media, LLC, Fifth edition.

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

1. Introduction to Hardware Modeling using verilog by IIT KHARAGPUR - Bing video
2. Introduction to VERILOG LANGUAGE FEATURES PART 1 by IIT KHARAGPUR - Bing video
3. System Design Through VERILOG - Course (nptel.ac.in)
4. VERILOG MODELING OF THE PROCESSOR PART 1 using Verilog by IIT KHARAGPUR - YouTube
5. Hardware Design Representation by IIT KHARAGPUR - YouTube

E-content: (Presidency University E-resources)

1. Verilog HDL based FPGA design | IEEE Conference Publication | IEEE Xplore
2. Towards Optimised FPGA Realisation of Microprogrammed Control Unit Based FIR Filters | IntechOpen
3. Improvisation of Gabor Filter design using Verilog HDL | IEEE Conference Publication | IEEE Xplore
4. Behavioral modeling and simulation of analog/mixed-signal systems using Verilog-AMS | IEEE Conference Publication | IEEE Xplore
5. Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language | IEEE Conference Publication | IEEE Xplore
6. https://presiuniv.knimbus.com/openFullText.html?DP=http://182.72.188.196/LocalGuru/

Topics related to development of "FOUNDATION": Digital Systems and Embedded Systems, Real-World Circuits, Models, Design Methodology

Topics related to development of "EMPLOYABILITY": Programmable Logic Devices, Packaging and Circuit boards, Interconnection and Signal integrity

Topics related to development of "ENTREPRENEURSHIP": I/O Interfacing

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Methods of Error Detection and Correction.

Catalogue prepared by	Ms. Maitraiyee Konar
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: ECE2573	Course Title: Digital VLSI Design Lab Type of Course: Program Core Lab	L- T-P- C	0	0	2	1
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 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) and Cadence 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	The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	CO1 Discuss the basic concepts of VLSI design. Understand CO2 Interpret the MOS transistor theory. Understand CO3 Evaluate the working of various CMOS combinational and sequential circuits. Understand CO4 Develop combinational and sequential circuits using Hardware Description Language. Apply CO5 Compute various design parameters of digital circuits using Vivado tool Apply					
Course Content:						

List of Laboratory Tasks:

Lab 0: Familiarization of Vivaldo Tools.

Lab experiments: (All the experiment given below must use test benches to verify the results)

1. To Verify all Logic Gates using Verilog. Level 1. For the connections of two bulbs there are various ways available, to 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 (All are Compulsory).

2. Write a Verilog code for Half Adder, Half Subtractor, Full Adder and Full Subtractor. Verify its truth table: Construct a circuit and implement using FPGA to compute addition and subtraction of single bit binary numbers, with Consideration of carry (Borrow) and without considering carry(Borrow). Construct a circuit to implement using FPGA 4-bit ripple carry adder using 1-bit full adder as a sub-block. (All Compulsory)
3. Write a Verilog code for Multiplexer, De-multiplexer and Decoder using Verilog. Verify its truth table. Implement using FPGA 3-to-8 decoder circuit using Verilog 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.
4. Write a Verilog code for SR, JK, D & T Flip Flops and Counter using Verilog and implement using FPGA. Verify its truth table Construct SR flip-flop, D Flip-flop and JK Flip-flop including a chip select/enable signal with Verilog using case statement and consider falling edge of clock. (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.
5. Design and simulate the 2:1 Mux using Pass Transistor Logic (PTL) and Transmission Gate(TG) in Cadence, Create Symbol and layout of 2:1 mux. (All 3 are Compulsory)
6. Design and simulate the 2- input Domino CMOS NAND Gate in Cadence, simulate leakage effects and compare with static CMOS.
7. Design 6T-SRAM cell in Cadence, perform read/write stability analysis using DC & transient simulations.
8. Design 1T-1C DRAM cell in Cadence, simulate refresh operation and leakage effects.
9. Design an H-tree clock network in cadence, analyze skew and jitter effects.(Optional Experiments).

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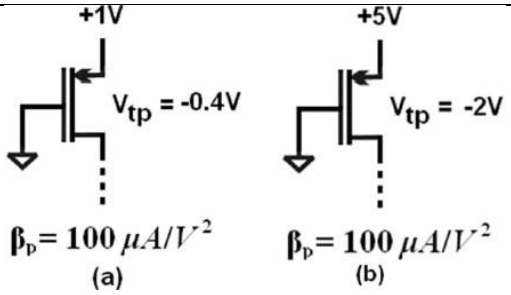
Targeted Application & Tools that can be used:
Targeted Applications:
Professionally Used Software: Xilinx & Cadence Virtuoso

Project work/Assignment:

10. Why pseudo nMOS logic circuits are called ratioed circuits? Substantiate your answer with suitable transfer characteristics of pseudo-nMOS inverter.
11. Sketch a transistor-level schematic of a CMOS complex logic gate that realizes (a) the function F(=A+B')(C+D)and(b)draw stick diagram of the same complex logic gate.
12. The source voltage, threshold voltage and gain factor is given. Analyze the highest voltage that can be applied to the drain for the device to operate in saturation? Neglecting the channel length modulation effect (i.e., $\lambda = 0$), also determine the drain current of Fig. (a) for VD = −0.4 V and drain current of Fig. (b) for VD = −5 V.



Text Books:

5. N. Weste and D. Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", Addison- Wesley.

Reference(s):

Reference Books

1. Mano, M. Morris and Ciletti Michael D., "Digital Design", Pearson Education.
2. N. Weste and K. Eshraghian, "Principles of CMOS VLSI Design", Addison-Wesley.
3. Sung Mo Kang, Yusuf Leblebici"CMOS Digital Integrated Circuits " Mc Gram Hill Education 4th Edition.
4. Douglas A Pucknell Kamran Eshraghain" Basic VLSI Design" Third Edition.
5. Debaprasad Das "VLSI Design" Second Edition.

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

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

E-content:

- Sharma, Shashank, Syed Azeemuddin, and Mohd Anwar. "A self learning VLSI lab along with web-based platform to design schematics and layouts." 2011 IEEE International Conference on Technology for Education. IEEE, 2011. https://ieeexplore.ieee.org/document/6004383
- K. Zhang, "Challenges and opportunities in nano-scale VLSI design," 2005 IEEE VLSI-TSA International Symposium on VLSI Design, Automation and Test, 2005. (VLSI-TSA-DAT)., 2005, pp. 6-7, doi: 10.1109/VDAT.2005.1500005. https://www.semanticscholar.org/paper/Challenges-and-opportunities-in-nano-scale-VLSI-Zhang/6f7f110c5cbb3304a458ceacf0bb530d8c60099c
- 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
- 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
- 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

5.Presidency University Library Link:-https://presiuniv.knimbus.com/user#/home
Topics related to the development of "FOUNDATION SKILLS": Topics related to the development of "EMPLOYABILITY": .

Course Code: ECE2528	Course Title: RF and HF IC Design Type of Course: Program Core	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic Analog and Digital Electronics, Electronic Devices, MOSFET operation.					
Anti-requisites	Nil					
Course Description	This course introduces the design principles of RF (Radio Frequency) and HF (High Frequency) integrated circuits, focusing on device behavior at high frequencies, impedance matching, RF amplifiers, oscillators, mixers, and frequency synthesizers. It combines theoretical foundations with circuit-level design considerations, covering CMOS RF circuit components and practical IC layout constraints. Students will analyze the impact of parasitics, non-idealities, and noise in RF systems and simulate critical RF building blocks. The course prepares students to work on wireless communication system design, radar systems, and high-speed analog front-ends for modern SoC solutions.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of RF and HF IC design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of the course the students shall be able to: 10. Explain the physical principles and challenges in RF and HF circuit design. 11. Analyze the performance of RF components including amplifiers, mixers, and oscillators. 12. Design and simulate RF building blocks using CMOS technology. 13. Interpret S-parameters, noise figures, and matching network requirements for RF ICs. 14. Evaluate RF circuit layout considerations and parasitic effects in integrated design.					
Course Content:						
Module 1	Introduction to RF and	Assignment/ Quiz	Numerical	10		

	HF Circuit Design		solving Task	Sessions
Overview of RF applications: wireless, radar, biomedical, Frequency spectrum and standard RF bands, High-frequency behavior of MOSFETs and BJTs, Small-signal high-frequency models, Introduction to parasitics, Q-factor, and layout limitations, Basics of S-parameters and impedance transformation				
Module 2	Matching Networks, LNA Design, and Noise Analysis	Assignment/ Quiz	Numerical solving Task	12Sessions
Impedance matching using L-section, Pi, and T networks, Noise figure, gain, linearity metrics (IIP3, P1dB), Narrowband vs broadband LNA, Design of common-source and inductively degenerated LNA, S-parameter-based stability analysis				
Module 3	Mixers and Oscillators	Assignment/ Quiz	Numerical solving Task	12 Sessions
Mixer types: passive, active, Gilbert-cell mixer, Non-linearity, isolation, conversion gain, Local oscillator feedthrough, LC and ring oscillators, Phase noise, startup conditions, oscillator tuning				
Module 4	Frequency Synthesizers and Layout Considerations	Assignment/ Quiz	Numerical solving Task	12 Sessions
PLL-based frequency synthesis, VCO design, frequency dividers, loop filter, Charge pump design challenges, Parasitics in layout, Q of on-chip inductors, EM simulation and layout extraction techniques				
Targeted Application & Tools that can be used: Applications: RF transceivers, 5G modems, radar systems, Bluetooth, Wi-Fi chips Tools: Cadence Virtuoso, Keysight ADS, Ansys HFSS, LTspice, Spectre RF				
Project Work/ Assignment:				
1. 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): 9. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed., Cambridge University Press, 2004. 10. Behzad Razavi, RF Microelectronics, 2nd ed., Pearson Education, 2011.				
Reference Book (s): 10. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design, 2nd ed., Pearson, 2009. 11. Ali Hajimiri, Design Issues in CMOS Oscillators, IEEE Journal of Solid-State Circuits, 1999. Online Resources (e-books, notes, ppts, video lectures etc.): 1. https://nptel.ac.in/courses/117101105 – NPTEL RFIC Design 2. https://www.designers-guide.org – Industry best practices for analog/RF 3. https://ieeexplore.ieee.org – IEEE for latest RF research 4. https://ocw.mit.edu – MIT OpenCourseWare on RF systems				
Topics relevant to "SKILL DEVELOPMENT": his course is designed to equip students with industry-relevant skills in CMOS RFIC design and verification. Through simulation and analysis, students will engage in applying S-parameter techniques, modeling PLL/VCO architectures, and designing noise-optimized amplifiers. Additionally, they will practice layout-versus-schematic verification to ensure design integrity, preparing them for roles in wireless communication, semiconductor design, and high-frequency system development.				
Catalogue prepared by				
Recommended by the Board of Studies on				
Date of Approval by the Academic Council				

DISCIPLINE ELECTIVES

GENERAL BASKET

Course Code: ECE3200	Course Title: Measuring Instruments and Sensors Type of Course: Discipline Elective Theory	L-T-P-C	3	0	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	The objective of the course is to familiarize the learners with the concepts of Measuring Instruments and Sensors and attain EMPLOYABILITY SKILLS through _PARTICIPATIVE LEARNING.				
Course Outcomes	On successful completion of this course the students shall be able to: 1. Discuss the concepts of measuring systems and error in measurement. 2. Demonstrate various types of Analog and Digital Instruments. 3. Analyze various types of sensors and transducers. 4. Compute the unknown parameters using bridge circuits.				
Course Content:					
Module 1	Measurements and Measuring Systems, Error in measurement and their statistical Analysis	Assignment/quiz	Programming Task		13Sessions
Topics: Significance of measurements, Methods of Measurement- Direct and Indirect Methods, True Value, Static Error, Static Correction, Error Calibration Curve, Accuracy and Precision, Static Sensitivity, Linearity. Hysteresis, Dead Time, Dead Zone, Resolution or Discrimination, Types of Errors, Arithmetic Mean, Range, Deviation, Average Deviation, Standard Deviation (S.D.), Variance. Programming Assignment					
Module 2	Storage and display devices	Assignment/quiz	Data collection and simulation task		12 Sessions
Topics: D.C. and A.C. Bridges (Measurement of resistance, capacitance and Inductance), Digital Voltmeter (DVM), Digital Multimeter (DMM), Square and pulse generator, Relaxation oscillator. Simulation based assignment					
Module 3	Sensors and Transducers	Assignment/quiz	Data collection and simulation task		15 Sessions
Topics: Basic Principles of Operation, Different types of transducers, Resistive, Capacitive, Linear Variable differential transducer (LVDT), piezoelectric transducer, Temperature transducers, Pressure Transducers, Proximity Sensor. Simulation based assignment					
Targeted Application & Tools that can be used:					

Application Area is AWA-Biosensor BOD analyser,bio medical field ,Analog devices, Automatic process control, chemical sensors and analytical instruments
Professionally Used Software: MATLAB/ Lab VIEW NI Lab-VIEW
NI ELVIS II+ Workstation, NI myDAQ

Text Book(s):

1. A. K. Sawhney, "Electronics and Electrical Measurements", Dhanpat Rai and Sons. 4th Edition, 2017.

References

1. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press / PHI. 2nd Edition, 2006.
2. H. S. Kalsi, "Electronic Instrumentation", McGraw Hill., 4th Edition, 2018.
3. Online videos of lab-VIEW compatible NI devices., 2nd Edition, 2019.

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

1. Video lectures on measuring instruments and sensors - https://nptel.ac.in/courses/108/105/108105153/
2. Coursera - https://www.coursera.org/learn/sensors-circuit-interface
3. Udemy - https://www.udemy.com/course/electronic-measurements-and-instrumentation/

E-Content:

1. H. Liu, W. Sun, Q. Chen and S. Xu, "Thin-Film Thermocouple Array for Time-Resolved Local Temperature Mapping," in *IEEE Electron Device Letters*, vol. 32, no. 11, pp. 1606-1608, Nov. 2011, doi: 10.1109/LED.2011.2165522.
2. S. F. Ali and N. Mandal, "Design and Development of an Electronic Level Transmitter Using Inter Digital Capacitor," in *IEEE Sensors Journal*, vol. 19, no. 13, pp. 5179-5185, 1 July1, 2019, doi: 10.1109/JSEN.2019.2903296.
3. S. F. Ali, P. Maurya and N. Mandal, "Development of PLC Based Reluctance type Target Flow Control System," *2020 IEEE International Conference for Innovation in Technology (INOCON)*, 2020, pp. 1-5, doi: 10.1109/INOCON50539.2020.9298292.
4. B. Mondal, R. Sarkar and N. Mandal, "Design and Implementation of an RF-Based Wireless Displacement Transmitter," in *IEEE Sensors Journal*, vol. 20, no. 3, pp. 1383-1392, 1 Feb.1, 2020, doi: 10.1109/JSEN.2019.2947318.

Topics relevant to "EMPLOYABILITY SKILLS": Methods of Measurement, types of error, resolution for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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	Meeting No. 16th , Dated 23/10/2021

Council	

Signal Processing Basket

Course Code: ECE3400	Course Title: Speech Signal Processing Type of Course: Discipline Elective Theory only	L- T-P-C	3	0	0	3
Version No.		2.0				
Course Pre-requisites		[1] Digital Signal Processing [ECE3005] Basic concepts like Energy, Magnitude, Zero Crossing rate, Autocorrelation function, pole zero analysis, DFT and some basic mathematical concepts.				
Anti-requisites		NIL				
Course Description		The purpose of this course is to introduce basic principle of speech production and perception, speech processing oriented to human-computer interaction, categorization of speech sounds based on the source-system. This course also develops speech recognition and verification models. The course offers a practical and theoretical understanding of how human speech can be processed by computers. The course deals with the details of algorithms, techniques and limitations of state of the art speech systems. The course involves quizzes and programming assignments using MATLAB based programming and using Goldwave and Audacity tools for speech analysis.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of Speech Signal Processing to improve the learners' Employability Skills by using Participative Learning techniques.				
Course Outcomes		On successful completion of this course the students shall be able to: 1) Understand the fundamental concepts of speech production 2) Discuss short time principles in digital speech processing to understand various parameters of speech. 3) Demonstrate the properties of speech in the context of "frequency domain analysis". 4) Analyze different types of speech processing and its applications.				
Course Content:						
Module 1	Fundamentals of Human Speech Production	Quiz		Memory Recall based Quizzes and assignments/simulation task	10 Sessions	
	Topics: Introduction to Speech, The Mechanism of speech production, Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates					
Module 2	Discrete time speech signals	Assignment		Comprehension based Quizzes and assignments; simulation	10 Sessions	

				with MATLAB	
	Topics: Introduction, Time dependent processing of speech, short time energy and average magnitude, short time Average zero crossing rate, Speech vs. silence discrimination using Energy and Zero Crossings, Pitch period estimation using parallel processing approach				
Module 3	Frequency domain methods for speech processing	Assignment		Comprehension based Quizzes and assignments; 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.				
	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 "EMPLOYABILITY SKILLS": Speech vs. silence discrimination using Energy and Zero Crossings, Pitch period estimation using parallel processing approach, Fourier Transforms interpretation and Z transform interpretation of speech signal, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Ms. Aruna M Ms. Anupama Sindgi Mr. Arvind Kumar
Recommended by the Board of Studies on		12th BOS held on 10/08/2021
Date of Approval by the Academic Council		Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3401	Course Title: Digital Image Processing Type of Course: Discipline Elective in Signal Processing Basket – Theory and Integrated lab	L-T-P-C	3	0	2	4
Version No.		2.0				
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 to familiarize the learners with the concepts of Digital Image Processing 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. 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.

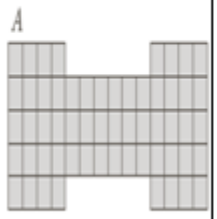
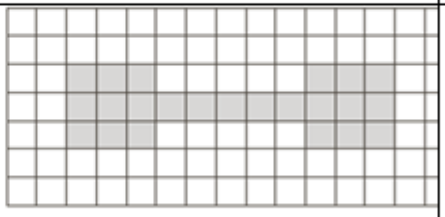
A

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	Morp al Op
			

Targeted Application & Tools that can be used:

Applications of Digital Image Processing: Acquisition of instant information has become possible because of the advancements taking place in the domain of the internet. Image processing is already being used by a diverse range of companies and it holds a huge potential of wide adoption in the future. The students will be able to

	find career opportunities in various domains such as: • Image sharpening and restoration. • Medical field. • Remote sensing. • Transmission and encoding. • Machine/Robot vision. • Color processing. • Pattern recognition. • Video processing. Professionally Used Software: MATLAB is an extraordinary tool for making image processing applications and is generally utilized in research as it permits quick prototyping
	Test Book(s): 1. Gonzalez, R. C. & R. E. Woods, "Digital Image Processing", Pearson Education, 3rd edition. 2009
	Online Resources (e-books, notes, ppts, video lectures etc.): 1. Video lectures on "Digital Image Professing" by Prof. Dr. P K Biswas, IIT Kharagapur. https://freevideolectures.com/course/2316/digital-image-processing-iit-kharagpur 2. https://www.coursera.org/learn/digital 3. https://nptel.ac.in/courses/117/105/117105135/ Reference(s): Reference Book(s): 1. Y. Wang, J. Ostermann, and Y.Q.Zhang, "Video Processing and Communications,", Prentice Hall, First Edition 2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach," Prentice Hall; First Edition 3. Richard Hartley, Andrew Zisserman, "Multiple View Geometry in Computer Vision," Cambridge University Press, Second Edition Online Resources (e-books, notes, ppts, video lectures etc.): 1. Online notes :- https://web.eecs.umich.edu/~justincj/teaching/eecs442/WI2020/syllabus.html# 2. NPTEL online video content:- https://onlinecourses.nptel.ac.in/noc21_ee23/preview 3. Online ppts :- http://www.wu.ece.ufl.edu/courses/eee6512f16/index.htm 4. Online ppts:https://staff.fnwi.uva.nl/r.vandenboomgaard/IPCV20172018/20172018/syllabus.html E-content: 1. K. Rasool Reddy; K. Hari Priya; N. Neelima , " Object Detection and Tracking -- A Survey 2015 International Conference on Computational Intelligence and Communication Networks (CICN) https://ieeexplore.ieee.org/document/7546127 2. Hammad Naeem; Jawad Ahmad; Muhammad Tayyab ," Real-time object detection and tracking", IEEE International Conference on Multi Topic-INIMC, December 2013 https://ieeexplore.ieee.org/document/6731341 3. Vijeta Sharma; Manjari Gupta; Ajai Kumar; Deepti Mishra , " Video Processing Using Deep Learning Techniques: A Systematic Literature Review ", IEEE Access ,

	VOL. 9 https://ieeexplore.ieee.org/document/7322178 4. Sahar Movaghati, Alireza Moghaddamjoo, Ahad Tavakoli," Road Extraction From Satellite Images Using Particle Filtering and Extended Kalman Filtering IEEE Transactions on Geoscience and Remote Sensing , VOL. 48, issue.7 https://ieeexplore.ieee.org/document/5439693
	Topics relevant to "EMPLOYABILITY SKILLS": Representation of Digital Images, Image operation, Image segmentation, Image Analysis, Color And Morphological Image Processing, for developing Employability Skills through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Dr K BhanuRekha, Annapurna.H.S
Recommended by the Board of Studies on		12th BOS held on 10/08/2021
Date of Approval by the Academic Council		Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3403	Course Title: Adaptive Signal Processing Type of Course: Discipline Elective / Signal Processing Basket and Theory Only	L- T-P-C	3	0	0	3

Version No.		2.0
Course Pre-requisites		Digital Signal Processing Signal and Systems
Anti-requisites		NIL
Course Objective		The objective of the course is to familiarize the learners with the concepts of Adaptive Signal Processing to improve the learner's Employability Skills of student by using Participative Learning techniques
Course Description		The course aims to develop a mathematical theory of linear adaptive filters. The course discusses the adaptation techniques of the filter to achieve the desired output. Such adaptive algorithms are frequently encountered in many signal processing and machine learning algorithms. The adaptive signal processing course will be aided by simulations, which will enable the students to validate their theoretical findings.

Course Outcomes		On successful completion of this course the students shall be able to: 1. Recognize the importance of signal processing in non-stationary environment. 2. Discuss the role of adaptive signal processing in communication systems. 3. Apply the various mathematical models to adaptive signal processing. 4. Use of Weiner filter for given applications.			
Course Content:					
Module 1	Introduction/Stationary Processes and Model	Assignment/QUIZ	Memory Recall based quiz		10 Sessions
	Topics: INTRODUCTION: The filtering problem, Adaptive filters, linear filter structures, approaches to the development of linear adaptive filter algorithms, real and complex forms of adaptive filters, nonlinear adaptive filters, Applications. STATIONARY PROCESSES AND MODELS: Partial characterization of a discrete time stochastic process, mean ergodic theorem, correlation matrix, correlation matrix of sine wave plus noise, stochastic models, Wold decomposition, asymptotic stationarity of an auto regressive process. Yule-Walker equations				
Module 2	WIENER FILTERS	Assignment	Simulation task		10 Sessions
	Topics: WIENER FILTERS: Linear optimum filtering problem statement, principle of orthogonality, minimum mean squared error, Wiener Hopf equations, error performance surface. Channel equalization. Linearly constrained minimum variance filter, generalized side lobe cancellers.				
Module 3	Linear Prediction	Assignment	Simulation task		10 Sessions
	Topics: LINEAR PREDICTION: Forward Linear Prediction, backward Linear Prediction, Levinson-Durbin algorithm, properties of prediction error filters, Schur-Cohntest, auto regressive modeling of a stationary stochastic process. Method of steepest descent: Steepest descent algorithm, stability of the Steepest descent algorithm.				
Module 4	Applications of Adaptive signal processing	Assignment	Simulation task		10 Sessions
	Topics: Adaptive modeling of a multi-path communication channel, adaptive model in geophysical exploration, Inverse modeling, Adaptive interference canceling: applications in Bio-signal processing.				
	Targeted Application & Tools that can be used: Application Area includes all modern electronic devices (Music System, cellular phones, computers, digital cameras, high-definition smart televisions, Home Automation, Communication systems). Tools that can be used: Signal processing tool box in MATLAB				
	Text Book(s): **1.** Simon Haykin, " Adaptive Filter Theory", Pearson Education, 2003 **2.** Ali H. Sayed, Fundamentals of Adaptive Filtering, John Wiley, 2003				
	References 1. Bernard Widrow and Samuel D. Stearns, "Adaptive Signal Processing", Person				

	Education, 2005. 2. John R. Treichler, C. Richard Johnson, Michael G. Larimore, "Theory and Design of Adaptive Filters", Prentice-Hall of India, 2002 3. S. Thomas Alexander, " Adaptive Signal Processing - Theory and Application", Springer-Verlag. 4. James V. Candy, Signal Processing: A Modern Approach, McGraw-Hill, International Edition. Online Resources (e-books, notes, ppts, video lectures etc.): 1. Video lectures on "Adaptive Signal Processing" by Prof. Mrityunjoy Chakraborty, IIT KGP https://nptel.ac.in/courses/117105075 2. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: 1. D.Morgan, "Adaptive signal processing" IEEE Trans. on Acoustics, Speech, and Signal Processing Vol 34, (4) 1986) **DOI:** 10.1109/TASSP.1986.1164869. 2. Alexander Voznesensky; Dmitrii Kaplun, "Adaptive Signal Processing Algorithms Based on EMD and ITD", IEEE Access (Volume: 7), **DOI:** 10.1109/ACCESS.2019.2956077. 3. B. Widrow; E. Walach Adaptive signal processing for adaptive control", **DOI:** 10.1109/ICASSP.1984.1172527. 4. Alexander Voznesensky; Dmitrii Kaplun, " Adaptive Signal Processing Algorithms Based on EMD and ITD", IEEE Access Vol 7,2019 DOI: 10.1109/ACCESS.2019.2956077
	Topics relevant to "EMPLOYABILITY SKILLS": WIENER FILTERS, Linear optimum filtering problem statement, Adaptive filters, Channel equalization, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3402	Course Title: Biomedical Signal Processing Type of Course: Discipline Elective Theory only	L- T-P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts and techniques for processing of discrete-time signals, systems and transforms. Understanding of FIR and IIR Filters; Discrete Fourier Transform (DFT) and Fast Fourier transform (FFT) techniques and their applications; Implementation of DSP algorithms on DSP processors.					
Anti-requisites	NIL					
Course Description	The course describes the origin and characteristics of biomedical signals collected from humans. This course imparts knowledge of signal processing methods to analyze the health status of individuals in order to differentiate between a healthy and an unhealthy person. The course also develops critical					

		thinking to choose and apply a signal model for a specific set of physiological disorders. The comprehensive nature of the course covers a number of quizzes and signal processing assignments using various tools to enhance students' abilities to become an independent biomedical engineer.
Course Objective		The objective of the course is to familiarize the learners with the concepts of Biomedical Signal Processing and to improve the Employability Skills of student by using Participative Learning techniques.
Course Outcomes		On successful completion of this course the students shall be able to: (i) Discuss the origin and characteristics of various biosignals. (ii) Apply various analog and digital filtering techniques for removal of noise and artifacts. (iii) Demonstrate various feature extraction and event detection techniques using time-domain as well as frequency-domain analysis methods. (iv) Employ various parametric and non-parametric models of certain physiological systems.
Course Content:		

Module 1	Biosignals and its Origin	Quiz		Memory Recall based Quizzes	12 Classes
	Introduction to biosignals: Human anatomy and physiology, Electrical activities of a Cell, Origin and dynamics of Biomedical signals, Electrocardiography (ECG) signal origin and characteristics. Electroencephalography (EEG) signal and its characteristic. Electromyography (EMG) signal and its characteristic. Other Biomedical signals – Blood Pressure, Respiration, Electrooculogram (EOG) etc.				
Module 2	Noise Removal and Processing of Biosignals	Assignment / Quiz		Programming and Simulation task	12 Classes
	Review of Discrete time signals and systems, Analog filters, Digital filters. Time domain filtering - Synchronized Averaging, Moving Average etc., Frequency Domain Filtering, The Weiner Filter, Adaptive Filtering, Adaptive interference cancellation. Filtering of physiological signals.				

Module 3	Analysis of Biosignals	Assignment	Memory Interfacing Task and Analysis	15 Classes
Practices followed for data collection from opposite gender patients. Feature Extraction and Event Detection from ECG (P, QRS and T Waves detection, Pan Tompkins Algorithm for QRS Detection), EEG and EMG signals. Time-domain Analysis – Biosignal Morphologies, Signal length, Envelop Extraction, Amplitude demodulation, The Envelogram, Activity Analysis etc. Frequency-domain Analysis – Periodogram, Averaged Periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, and Measures derived from Power Spectra Density.				
Module 4	Modelling of Biomedical Signals and Systems	Assignment	System Design Task and Analysis	06 Classes
Parametric Modelling of Biomedical Systems, Various Signal models like Autoregressive, Autocorrelation method, ARMA model etc., Random signals and their processing, Overview of Advanced Topics.				

Targeted Application & Tools that can be used:

Application Area is Biomedical Signal Processing applications leading to design of medical devices and systems.

Professionally Used Software: Matlab / Python / LabVIEW.

Textbook(s):

1. Sörnmo L. and Laguna P, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", Academic Press, 1st edition, Elsevier, 2005.
2. Willis J. Tompkins " Biomedical Digital Signal Processing", 2nd edition, EEE, PHI, 2004.

Reference(s):

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

7. 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/
8. Prof. Sudipta Mukhopadhyay NPTEL Lecture Notes and Videos: https://nptel.ac.in/courses/108105101
9. Fatemeh Hadaeghi Lecture Notes (from Jacobs University Bremen): https://www.ai.rug.nl/minds/teaching/courses/t2018biomed/
10. Dr. Kunal Pal's Video lectures on "Biomedical Signal Processing" from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8
11. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

14. 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
15. 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
16. 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
17. 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
18. Moraes, Jermana L., Matheus X. Rocha, Glauber G. Vasconcelos, José E. Vasconcelos Filho, Victor Hugo C. De Albuquerque, and Auzuir R. Alexandria. "Advances in photopletysmography signal analysis for biomedical applications." *Sensors* 18, no. 6 (2018): 1894. https://www.mdpi.com/1424-8220/18/6/1894/pdf

Topics relevant to "EMPLOYABILITY SKILLS": Analysis of ECG / EMG / EEG signals, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Ms. Natya.S
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3404	Course Title: Multimedia Signal Processing Type of Course: Discipline Elective from Signal Processing Basket & Theory only		L- T-P-C	3	0	0	3
Version No.		2.0				
Course Pre-requisites		A fair knowledge in digital signal processing and basic concepts of frequency transformations is desirable.				
Anti-requisites		NIL				
Course Description		This is an undergraduate level course that deals multimedia presentations (text, graphics, speech, audio, image, video) and their standards for coding, processing and compression. The subject shall provide an introduction to our perception of speech, audio, music, image and video to be able to understand advanced techniques, algorithms and concepts for digital processing of multimedia presentations. The course enables to know the principles and technologies of several important standards and their typical application scenarios.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of Multimedia Signal Processing to improve the learner's Employability Skills by using Participative Learning Methodologies.				
Course Outcomes		On successful completion of this course the students shall be able to: 1) Discuss the fundamentals behind multimedia signal processing and compression. (Comprehension) 2) Explain the basic principles behind existing multimedia compression and communication standards. (Comprehension) 3) Apply the acquired knowledge to specific multimedia related problems and projects at work. (Application)				
Course Content:						
Module 1	Basic Digital Signal Processing	Assignment		Programming Task, Data Analysis task		12 classes

	Topics: Digital Processing Basics, Multimedia Processing and Communications, Compression and Networking as Cornerstones, Information Theory Basics, Lossless Source Coding, Huffman/arithmetic Codes, LZW, Text/graphics Compression, Quantization (scalar/vector). Ethical practices to be observed while using multimedia techniques.				
Module 2	Model Based Signal Processing	Assignment		Programming Task, Data Analysis task	10 classes
	Topics: Waveform, Transform, Model-based Coding, Performance Criteria, Perception, Human Visual System Models, Still Image Compression, JPEG, JPEG2000, Wavelet/Sub-band/Fractal, Perceptually-based Coders, 2 nd Generation Image Coding				
Module 3	Multimedia Communication Standards	Project		Programming Task, Data Analysis task	11 classes
	Topics: Audio Compression, MPEG-1/2, Dolby AC-2 and AC-3, Compression of Stereo and Surround Sound, Video Compression Basics, Overview of Multimedia Communication Standards H.323 and H.324, Video Compression Standards H.261, H.263, Video Compression Standards MPEG-1, MPEG-2, and HDTV, MPEG-4, MPEG-7, Multimedia Transmission, Error Resilience and Concealment, Multimedia over IP				
Module 4	Applications of DSP to 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				
	Textbook(s): 1. Saeed V. Vaseghi, "Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications", Wiley.				
	References: 1. Ralf Steinmetz and Klara Nahrstedt, "Multimedia Systems", Springer 2. Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", John Wiley Online Resources (e-books, notes, ppts, video lectures etc.): 1. Multimedia Signal Processing | University of Illinois https://courses.engr.illinois.edu/ece417/fa2020/ 2. Multimedia Signal Processing | Norwegian University of Science and Technology https://www.ntnu.edu/studies/courses/TTT4135 Other Resources: Presidency University Library Link https://presiuniv.knimbus.com/user#/home 1. Efficient and Low-Complexity Surveillance Video Compression Using Backward-Channel Aware Wyner-Ziv Video Coding, IEEE Transactions on Circuits and Systems for Video Technology (Volume: 19, Issue: 4, April 2009) https://ieeexplore.ieee.org/document/4801602 2. Sparse Music Representation With Source-Specific Dictionaries and Its Application to Signal Separation, IEEE Transactions on Audio, Speech, and Language Processing (Volume: 19, Issue: 2, February 2011)				

	https://ieeexplore.ieee.org/document/5444999
	Topics relevant to "EMPLOYABILITY SKILLS": Audio and video compression Standards, Digital Processing Basics for Multimedia Processing and Communications; Audio and Video Compression Basics, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3405	Course Title: Wavelets and Filter Banks Type of Course: Theory Only	L- T- P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Signal Processing; Matlab; Linear Algebra.					
Anti-requisites	NIL					
Course Description	The course mainly involves the theories of multirate filter banks (FBs) and wavelet, in addition, and their applications. It falls into two sections: FBs and wavelet. The first section begins with the design of filter, and then introduces the fundamental concepts, properties and theory of multirate FBs. Furthermore, several types of FBs, such as cosine-modulated FBs, linear phase FBs, time varying FBs, 2-dimmensional FBs, directional FBs, are analyzed. In the end of this section, the applications of FBs in communication are introduced.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using AI & IOT.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand the terminologies that are used in the wavelets literature. 2. Understand the concepts and theory behind wavelets constructions from an interdisciplinary 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		Theoretical	10		

	banks	Assignment/Quiz	Understanding	Sessions
Topics: *M*-channel linear phase filter banks, Multiresolution analysis and wavelet theory, Comparison of wavelet and Fourier transform,				
Module 3	Filter banks and discrete wavelet transform	Assignment/Quiz	Theoretical Understanding	11 Sessions
Topics: Wavelet with FIR and IIR filters I, Wavelet with FIR and IIR filters II, *M*-band wavelet, Wavelet design based on cosine modulated filter banks, Wavelet transform application: de-noising and compression, Matching wavelet.				

Targeted Application & Tools that can be used:

- Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans multiplexers, Text-Image Compression: Lossy and Lossless,
- Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis,
- Geometric Modelling, Matrix Preconditioning, Multiscale Methods for Partial Differential Equations and Integral Equations.

Professionally Used Software:

- MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs,
- Wavelet Transforms on Complex Geometrical Shapes.

Project work/Assignment:

1. Case Studies: At the conclusion of each module, we will have a 'case-based' discussion session for approximately half the class period. Cases will be from lecture / journal article content by considering a 'real-world' scenario where the course concepts can be applied. We will post the case one week in advance. For each case, each student from each group formed will write a 1-2-page executive summary outlining their understanding, including relevant analyses, schematics, and graphs. Guidelines on report format will be provided with the first case.

2. Book/Article review: At the end of each module, a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. Presidency University Library Link.

3. Presentation: There will a group presentation on latest trends and advancements in Wavelets & Filter banks

Text Book(s):

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks. Prentice-Hall. Englewood Cliffs, NJ: 1993.
2. G. Strang and T. Q. Nguyen, Wavelets and Filter Banks. Wellesley-Cambridge Press, Wellesley, MA, Revised Edition, 1998.
3. Stephane Mallat, A Wavlet Tour of Signal Processing. San Diego: Academic Press, 1999.

Reference(s):

1. M. Vetterli and J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, Englewood Cliffs, NJ, 1995.

2. Fusheng Yang, Engineering Analysis and Applications of Wavelet Transform. Science Press, BJ:1999.

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

1. NPTEL :: Electrical Engineering - NOC:Fundamentals of Wavelets, Filter Banks and Time Frequency Analysis
2. Lecture Notes | Wavelets, Filter Banks and Applications | Mathematics | MIT OpenCourseWare
3. Introduction to Wavelet.ppt (live.com)

E-content:

1. P. P. Vaidyanathan, "Multirate digital filters, filter banks, polyphase networks, andapplications: a tutorial", *Proc. IEEE*, vol. 78, no. 1, pp. 56-93, January 1990.
2. P. P. Vaidyanathan, "Theory and design of *M*-channel maximally decimated quadrature mirror filters with arbitrary *M,* having the prefect reconstructions property," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. 35, no. 4, pp. 476-492, April 1987.
3. R. D. Koilpillai and P. P. Vaidyanathan, "Cosine-Modulated FIR Filter Banks Satisfying Perfect Reconstruction," *IEEE Trans. Signal Processing,* vol. 40, no. 4, April 1992.
4. T.Q.Nguyen, "Near Perfect Reconstruction *Pseudo*-QMF Banks," *IEEE Trans. Signal Processing,* vol. 42, no. 1, pp. 65-76, January 1994.
5. T. Q. Nguyen, "A tutorial on Filter Banks and Wavelets," I*n Proc. IEEE International Conference on Digital Signal Processing,* Cypress, June 1995.
6. Y. P. Lin and P. P. Vaidyanathan, "Linear Phase Cosine Modulated Maximally Decimated Filter Banks with Perfect Reconstruction," *IEEE Trans. Signal Processing*, vol. 42, no. 11, November 1995.

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

Course Code: ECE3406	Course Title: Probabilistic Systems analysis Type of Course: Discipline Elective- Signal Processing Basket	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	A college-level course in calculus and statistics is desirable. The students should be aware of double integrations and methods for solving partial differential equations.					
Anti-requisites	NIL					
Course Description	This course provides insights into the modeling and analysis of real-world random phenomena and processes, including the basics of statistical inference. The course introduces the relevant models, skills and tools, by combining mathematics with conceptual understanding and intuition. The assignment-based practices in this course lay a firm foundation for building probabilistic models in various application domains.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using open source Design Tools.					
Course Outcomes	On successful completion of this course the students shall be able to: 1) Discuss the basics of probability, sample space, events, statistics and apply them to real life problems 2) Distinguish probability density and distribution functions for single and multiple random variables and calculate the statistical parameters for random variables 3) Apply the concept of random processes along with its parameters in estimating the correlation, covariance and PSD.					
Course Content:						
Module 1	Probability Theory and Probability Statistics	Assignment	Problem Solving Task	7 Sessions		
Topics: Probability models and axioms, Conditioning and Bayes' rule, Independence, Counting						
Module 2	Random Variables	Assignment	Problem Solving Task	10 Sessions		
Topics: Discrete random variables; probability mass functions; expectations, Discrete random variable examples; joint PMFs, Multiple discrete random variables: expectations, conditioning, independence, Continuous random variables, Multiple continuous random variables						
Module 3	Distribution Functions and Random Processes	Assignment	Problem Solving Task	11 Sessions		
Topics: Continuous Bayes rule; derived distributions, Derived distributions; convolution; covariance and correlation, Iterated expectations; sum of a random number of random variables, Bernoulli process, Poisson process, Markov chains, Weak law of large numbers, Central limit theorem, Bayesian statistical inference, Classical statistical inference						
Module 4	Detection, estimation and filtering	Assignment	Problem solving task	17 sessions		
Statistical decision theory - Bayes' criterion (Binary hypothesis, M-ary hypothesis), minimax criterion, Neyman-Pearson criterion, sequential detection, Estimation-maximum likelihood						

estimation, generalized likelihood ratio test, Bayes' estimation (minimum mean-square error estimate, minimum mean absolute value of error estimate, maximum a posteriori estimate), Cramer-Rao Inequality, Multiple Parameter Estimation, least-square estimation, Filtering-Wiener filter, Kalman filter

Targeted Application & Tools that can be used:

Application Areas: Exploratory decision making, Machine Learning, Artificial Intelligence and Data analysis, computer vision, natural language processing, computational biology, Statistics and Statistical Signal Processing Domain.

TOOLS: Python and R programming.

Project work/Assignment:

Assignment 1: Problem solving assignment on probability theory
Assignment 2: Problem solving assignment on random variables
Assignment 3: Problem solving assignment on random processes
Assignment 4: Problem solving assignment on queuing theory

Textbook(s):

1. Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2nd Edition, Wiley, 2016
2. Mourad Barkat, "Signal detection and estimation", 2e, Artech House, 2005

References:

1. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability. 2nd ed. Athena Scientific, 2008. ISBN: 9781886529236.

2. Athanasios Papoulis and S. Unnikrishnan Pillai, "Probability, Random Variables and Stochastic Processes", 4th edition, PHI, 2002.

3. Henry Stark and John W. Woods, "Probability and Random Processes with Application to Signal Processing", 3rd edition, Pearson Education, 2009

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

1. Probabilistic Systems Analysis and Applied Probability (amser.org)
2. Introduction To Applied Probability | Udemy
3. Probability Theory and Stochastic Processes with Applications
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content

1. https://www.researchgate.net/publication/309793344_Reliability_sensitivities_with_fuzzy_random_uncertainties_using_genetic_algorithm
2. https://www.researchgate.net/publication/333449747_Methodologies_for_Assessing_Risks_of_Accidents_in_Chemical_Process_Industries
3. https://www.researchgate.net/publication/226742073_Modelling_Technologies_and_Applications
4. https://www.researchgate.net/publication/327826061_Modelling_Technologies_and_Applications_Nanotechnologies_and_Electronics_Packaging

Topics relevant to development of "Foundation Skills": Probability models and axioms; probability mass functions; expectations.

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

<table>
<tr><td>Course Code: ECE3407</td><td colspan="3">Course Title: Video Processing and Computer Vision
Type of Course: : Discipline Elective-Signal Processing Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">Digital Image Processing, Signals and Systems, Transforms and Techniques</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">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.</td></tr>
<tr><td>Course Objective</td><td colspan="8">This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
1) 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</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Video Processing</td><td colspan="2">Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td colspan="2">09 session</td></tr>
<tr><td colspan="9">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Video Processing</td><td colspan="2">Assignment / Quiz</td><td colspan="2">Programming and Simulation task / Memory Recall based Quizzes</td><td colspan="2">12 session</td></tr>
<tr><td colspan="9">Topics:
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.</td></tr>
</table>

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 Vision	Assignment	Programming Assignment	12 session
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): 1. AL BOVIK, "Handbook of Image and Video Processing," Elsevier Science, 2nd Edition. 2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011, 1st Edition.				
Topics relevant to the: "FOUNDATION SKILLS", Introduction to Computer Vision, , Image Processing VS Computer Vision Topics related to development of "EMPLOYABILITY": Object detection and tracking various scenarios, Pattern Analysis, Face recognition and Tracking, Applications of computer vision in robotics and Autonomous Vehicles (ADAS)				
Catalogue prepared by	Mr. Kiran Dhanaji Kale			
Recommended	BOS Meeting NO: 15th BOS held on 28/07/2022			

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

VLSI DESIGN BASKET

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 switching, Memory Design**	Assignment/Project	Data Analysis	**10 Sessions**

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 ECE2566”, 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.):

8. Lecture videos for Low Power VLSI Circuits & Systems by Prof. Ajit Pal, IIT Kharagpur – NPTEL https://nptel.ac.in/courses/106/105/106105034/
9. PPT on Low Power VLSI Design, Link : https://nijwmwary.com/low-power-vlsi-circuits-systems/
10. 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

Embdeded System Basket

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 Modeling Building FPGA projects**	Assignment	Programming assignment	**13 Sessions**

Topics:
Design and test a Binary Coded Decimal Adder, Design and test a PWM Circuit, with verification by simulation. Design and test an ADC circuit, using Quartus Prime built-in tools to verify your circuit design. Enhance and test a working design, using most aspects of the Quartus Prime Design Flow and the NIOS II Software Build Tools (SBT) for Eclipse.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Application Area – Video imaging, Automotive computing, Aerospace applications. Signal processing, Medical devices

Professionally Used Software: PyCharm,Qt Creator,MATLAB,Eclipse,WebStorm

Project work/Assignment:

1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. **Presidency University Library Link .**
2.Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

3. Project Assignment- Implement various digital circuits in Verilog and verify the same on FPGA board., Write a report on the research article given., Explore the robotic application of embedded system with a research article and verify the coding done in the same.

Text Book

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

References

11. Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press,2011.
12. 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 :

7. 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
8. 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

9. 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

13.

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: ECE3421	**Course Title: 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 <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> 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:** 1. Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. 2. Demonstrate the importance of VHDL in real time applications. **3.** Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. **4.** 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):

9. Deisenroth, Faisal and Ong, "Mathematics for Machine Learning", Cambridge University Press, 1st Edition, 2020. Link: https://mml-book.github.io/book/mml-book.pdf
10. 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):

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

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

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

15. 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

Course Code: **ECE3052**	**Course Title:** **Introduction to Embedded Machine Learning** **Type of Course: General Basket Theory only**	**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 Embedded Systems. Basics of Python programming for Machine and Deep Learning Algorithms.				
Anti-requisites	**NIL**				
Course Description	**This course aims at provide introduction of an emerging field embedded machine learning. This course gives best possible insight of deploying machine learning applications on embedded systems using TinyML.**				
Course Objective	**This course is designed to improve the learners "ENTREPRENEURIAL SKILLS" by using EXPERIENTIAL LEARNING techniques in Embedded Machine Learning using "TinyML".**				
Course Outcomes	**On successful completion of this course the students shall be able to:** (i) Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. (ii) Demonstrate the importance of VHDL in real time applications. (iii) Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. (iv) Analyze the developed artificial intelligence based VHDL code for power, area and delay using the FPGA device				
Course Content:					
Module 1	**Overview of Machine Learning Algorithms**	Quiz	Memory Recall based Quizzes	**14 session**	
Supervised Learning, Regression- Linear Regression, Ridge Regression, LASSO, and Classifications of Supervised Learning: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, Perceptron, Logistic Regression, Unsupervised Learning- K-means Clustering, and PCA.					
Module 2	**Overview of Embedded Devices for Machine Learning Algorithms**	Assignment / Quiz	Programming and Simulation task	**12 session**	

RISC and CISC Architectures, Introduction to ARM® Architecture and ARM® Cortex™-M TM4C123X processor, Comparing ARM® Cortex™-M TM4C123X processor with TM4C129X architecture, FPGA.				
Module 3	**TinyML**	Assignment	Programming	**19 session**
Fundamentals of TinyML, Need of TinyML, Advantages, Deploying TinyML, Factors to be considered while deploying TinyM.				

Targeted Application & Tools that can be used:

JOBS-

- Execute a lead role for the design, development, and verification of real-time machine learning algorithms for innovative power tools.
- A state-of-the-art field that brings the performative power of ML to shrink deep structured earning networks to fit on tiny hardware.
- Implement machine learning algorithms in embedded environments.
- Manage the development of data collection methods, test plans/procedures and test cases for training, evaluation, and verification of machine learning algorithms.

TOOLS-

Python (NumPy, Pandas, sklearn, xgboost, TensorFlow, keras, etc.) MySQL, Snowflake, GCP/AWS and Tableau Java.

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):

11. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide, Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2nd Edition.
12. Pete Warden, Daniel Situnayake, "*TinyML*", 1st Edition, O'Reilly Media, Inc.

Reference Book(s):

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

The author, 2017.

18. 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

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

DISCIPLINE ELECTIVES

GENERAL BASKET

Course Code: ECE3200	Course Title: Measuring Instruments and Sensors Type of Course: Discipline Elective Theory	L-T-P-C	3	0	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	The objective of the course is to familiarize the learners with the concepts of Measuring Instruments and Sensors and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Discuss the concepts of measuring systems and error in measurement. 2. Demonstrate various types of Analog and Digital Instruments. 3. Analyze various types of sensors and transducers. 4. 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.				
Module 2	Storage and display devices	Assignment/quiz	Data collection and simulation task	12 Sessions
Topics: D.C. and A.C. Bridges (Measurement of resistance, capacitance and Inductance), Digital Voltmeter (DVM), Digital Multimeter (DMM), Square and pulse generator, Relaxation oscillat				
Module 3	Sensors and Transducers	Assignment/quiz	Data collection and simulation task	15 Sessions
Topics: Basic Principles of Operation, Different types of transducers, Resistive, Capacitive, Linear Variable differential transducer (LVDT), piezoelectric transducer, Temperature transducers, Pressure Transducers, Proximity Sensor.				
Targeted Application & Tools that can be used: Application Area is AWA-Biosensor BOD analyser,bio medical field ,Analog devices, Automatic process control, chemical sensors and analytical instruments Professionally Used Software: MATLAB/ Lab VIEW NI Lab-VIEW NI ELVIS II+ Workstation, NI myDAQ				
Text Book(s): A. K. Sawhney, “Electronics and Electrical Measurements”, Dhanpat Rai and Sons. 4th Edition, 2017.				
References David A. Bell, “Electronic Instrumentation and Measurements”, Oxford University Press / PHI. 2nd Edition, 2006. H. S. Kalsi, “Electronic Instrumentation”, McGraw Hill., 4th Edition, 2018. Online videos of lab-VIEW compatible NI devices., 2nd Edition, 2019.				
Online Resources (e-books, notes, ppts, video lectures etc.):				

Video lectures on measuring instruments and sensors - https://nptel.ac.in/courses/108/105/108105153/

Coursera - https://www.coursera.org/learn/sensors-circuit-interface

Udemy - https://www.udemy.com/course/electronic-measurements-and-instrumentation/

E-Content:

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.

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.

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.

B. Mondal, R. Sarkar and N. Mandal, "Design and Implementation of an RF-Based Wireless Displacement Transmitter," in IEEE Sensors Journal, vol. 20, no. 3, pp. 1383-1392, 1 Feb.1, 2020, doi: 10.1109/JSEN.2019.2947318.

Topics relevant to "EMPLOYABILITY SKILLS": Methods of Measurement, types of error, resolution for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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. 16th , Dated 23/10/2021

Course Code: ECE3205	Course Title: Object-Oriented Programming Essentials using JAVA Type of Course: Theory & Lab Integrated	L- T-P- C	2	0	2	3
Version No.	1.0					
Course Prerequisites	NIL					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive introduction to Object-Oriented Programming (OOP) principles using Java, covering core concepts such as classes, objects, encapsulation, inheritance, polymorphism, and abstraction. Through hands-on exercises and practical applications, students will learn to design, implement, and debug robust and reusable software solutions, gaining essential skills for modern software development.					
Course Objective	The primary objective of this course is to equip students with a solid understanding of Object-Oriented Programming (OOP) concepts and their practical application using the Java programming language. Students will learn to leverage OOP principles such as encapsulation, inheritance, and polymorphism to design, develop, and maintain efficient, modular, and scalable software solutions. By the end of the course, students will be capable of writing robust Java programs that adhere to OOP best practices and solve real-world problems.					
Course Outcomes	On successful completion of the course the students shall be able to: C.O. 1: Demonstrate a foundational understanding of core Object-Oriented Programming (OOP) concepts, including classes, objects, encapsulation, inheritance, polymorphism, and abstraction, and explain how these concepts contribute to modular and reusable code.. [Understanding] C.O. 2: Design and implement Java programs using OOP principles, effectively creating and manipulating objects, defining class relationships, and utilizing inheritance and interfaces to build structured and efficient applications [Application] C.O. 3: Apply problem-solving skills to analyze real-world scenarios and develop appropriate object-oriented solutions in Java, correctly identifying objects, their attributes, and behaviors, and designing class hierarchies.. [Application] C.O. 4: Write, debug, and test Java code that adheres to OOP best practices and standard coding conventions, resulting in readable, maintainable, and robust software solutions.. [Application]					
Course Content:						

Module 1	Introduction to Java	Assignment		10 Sessions
Topics: What is Java? History and features.JVM, JRE, JDK explained.Setting up the development environment (JDK installation, IDE introduction - e.g., IntelliJ IDEA, Eclipse).First Java program: "Hello World!" structure, main method,Variables, data types (primitive and non-primitive).Operators (arithmetic, relational, logical, assignment).Control flow statements: if-else, switch, for, while, do-while.Arrays (one-dimensional).Methods: defining, calling, parameters, return types.Procedural vs. Object-Oriented paradigms.The concept of objects and classes.Defining a class (blueprint).Creating objects (instantiation) using new keyword.State (attributes/fields) and Behavior (methods).Meaning and benefits of encapsulation.Access modifiers: public, private, protected, default.Getters and Setters methods.Constructors: default, parameterized.this keyword.				
Module 2	Classes and Relationship	Assignment		12 Sessions
Topics: Static Members static variables (class variables) and static methods (class methods).static initialization blocks.Difference between static and instance members.Object Relationships (Association) -Introduction to object relationships.Aggregation: "has-a" relationship (e.g., Car has an Engine).Composition: Stronger "has-a" relationship (e.g., House has Rooms).Implementing these relationships in Java. The final Keyword- final variables (constants).final methods (cannot be overridden).final classes (cannot be subclassed).Packages- Purpose and benefits of packages.Creating and using packages. import statement.Package naming conventions.Working with Strings-String class basics.String literals vs. new String().Common String methods (e.g., length(), charAt(), substring(), equals(), equalsIgnoreCase(), concat()).StringBuffer and StringBuilder (brief introduction to mutability).				
Module 3	Inheritance and Polymorphism	Term paper/Assignment		12 Sessions
Topics: Inheritance Fundamentals- What is inheritance? "is-a" relationship.Superclass (parent) and Subclass (child).Benefits: code reusability, extensibility.extends keyword.Constructor chaining in inheritance. Method Overriding- Rules for method overriding.@Override annotation.Using the super keyword to call superclass methods/constructors. Polymorphism- Definition and types of polymorphism (compile-time vs. runtime).Method Overloading (revisit as compile-time polymorphism).Runtime Polymorphism: object upcasting and downcasting.Dynamic Method Dispatch. Abstract Classes and Methods -Purpose of abstract classes and methods.Defining abstract classes and methods.Rules for abstract classes and their subclasses.When to use abstract classes vs. regular classes.				
Module 4	Interfaces, Exception Handling, and Introduction to Collections	Term paper/Assignment		12 Sessions

Topics:

Interfaces: What are interfaces? Purpose and characteristics.Abstract methods, default methods, static methods in interfaces.Implementing multiple interfaces.Interfaces vs. Abstract classes.Functional interfaces (brief introduction). Exception Handling-Understanding errors vs. exceptions.Types of exceptions: checked vs. unchecked.try-catch-finally block.throw and throws keywords. Creating custom exceptions. Introduction to Collections Framework -Why use collections?Overview of the Collections hierarchy (Collection, List, Set, Map).Basic usage of ArrayList and HashSet.Iterating over collections (enhanced for loop). Object Class and Object Equality - The Object class as the root of all classes.toString() method.equals() method: default behavior and overriding for custom equality. hashCode() method: overriding and its relation to equals().

List of Laboratory Tasks:

Module 1: Introduction to Java and Core OOP Concepts

1: Getting Started with Java and Basic Programs

Objective: Familiarize with the Java environment, basic syntax, and I/O.

Tasks:

Install JDK and configure your chosen IDE (IntelliJ IDEA Community Edition recommended).

Write a Java program that prints "Hello, Java OOP World!" to the console.

Write a program that takes two integer inputs from the user, calculates their sum, difference, product, and quotient, and prints the results.

Write a program to calculate the area and perimeter of a rectangle given its length and width.

2: Control Flow Statements

Objective: Practice using conditional and looping constructs.

Tasks:

Write a program that takes a student's score (0-100) as input and prints their grade (A, B, C, D, F) using if-else if.

Write a program that prints all even numbers from 1 to 50 using a for loop.

Write a program that calculates the factorial of a number using a while loop.

Implement a simple calculator that performs addition, subtraction, multiplication, or division based on user choice using a switch statement.

3: Introduction to Classes and Objects

Objective: Understand how to define a class and create objects.

Tasks:

Create a class named Dog with attributes: name (String), breed (String), and age (int).

Add a method bark() that prints "[Dog's Name] barks!".

In a main method, create two Dog objects, assign values to their attributes, and call their bark() method.

4: Encapsulation and Constructors

Objective: Implement encapsulation using getters/setters and various constructors.

Tasks:

Modify the Dog class from Lab 3. Make all attributes private.

Add public getter and setter methods for each attribute.

Implement a default constructor that initializes attributes to default values (e.g., name = "Unknown").

Implement a parameterized constructor that takes name, breed, and age as arguments.

In the main method, create Dog objects using both constructors and demonstrate calling getters and setters.

5: Advanced Class Features - this keyword and Methods

Objective: Master the this keyword and define more complex methods.

Tasks:

Create a class Book with private attributes: title (String), author (String), isbn (String), and isBorrowed (boolean).

Implement a parameterized constructor Book(String title, String author, String isbn) using the this keyword to resolve ambiguity.

Add methods:

borrowBook(): Sets isBorrowed to true and prints a confirmation. If already borrowed, print an error.

returnBook(): Sets isBorrowed to false and prints a confirmation. If not borrowed, print an error.

displayBookInfo(): Prints all book details.

In main, create Book objects and test all methods.

Module 2: Object Relationships and Advanced Class Features (Labs 6-10)

6: Static Members

Objective: Understand and apply static variables and methods.

Tasks:

Create a class BankAccount with private instance attributes: accountNumber (String), accountHolderName (String), balance (double).

Add a private static int nextAccountNumber = 1001; to generate unique account numbers.

Implement a static method generateAccountNumber() that returns nextAccountNumber and

increments it.

Implement a constructor that takes accountHolderName and an initial balance. This constructor should call generateAccountNumber() to set accountNumber.

Add a static method getNumberOfAccountsCreated() that returns the total count of bank accounts created (using another static variable).

In main, create several BankAccount objects and print the total number of accounts created.

7: Association (Composition)

Objective: Implement a strong "has-a" relationship using composition.

Tasks:

Create a class Engine with attributes type (String) and horsepower (int). Include a constructor and a displayEngineInfo() method.

Create a class Car with attributes make (String), model (String), and an Engine object.

The Car's constructor should take make, model, engineType, and engineHorsepower as arguments and create a new Engine object internally.

Add a startCar() method to Car that prints "Starting [Car Model] with a [Engine Type] engine."

In main, create Car objects and call their methods.

8: Association (Aggregation)

Objective: Implement a weaker "has-a" relationship using aggregation.

Tasks:

Create a class Address with attributes: street (String), city (String), zipCode (String). Include a constructor and a displayAddress() method.

Create a class Student with attributes: studentId (String), name (String), and an Address object.

The Student's constructor should take studentId, name, and an existing Address object as arguments (i.e., the Address object is passed in, not created inside Student).

Add a displayStudentInfo() method that also displays the student's address.

In main, create an Address object, then create multiple Student objects that share the same Address object to demonstrate aggregation.

9: The final Keyword and Packages

Objective: Understand final keyword and organize code using packages.

Tasks:

Create a final class MathConstants with a public static final variable PI = 3.14159;. Try to extend this class or change PI (observe compile errors).

Create a package named com.mycompany.utility and move MathConstants into it.

Create another package com.mycompany.geometry and a class Circle inside it.

The Circle class should have a radius (double) attribute and a calculateArea() method that uses MathConstants.PI (requires import statement).

In a main method (in a separate class, potentially in another package), create Circle objects and calculate their areas, demonstrating package import.

10: Working with Strings

Objective: Practice common String class methods.

Tasks:

Write a program that takes a sentence as input.

Print the length of the sentence.

Print the sentence in uppercase and lowercase.

Check if the sentence contains the word "Java" (case-insensitive).

Replace all occurrences of a specific word (e.g., "old") with another word (e.g., "new").

Extract the first five characters and the last five characters of the sentence.

Module 3: Inheritance and Polymorphism (Labs 11-15)

11: Single Inheritance

Objective: Implement single inheritance and understand super keyword for constructors.

Tasks:

Create a Shape class with attributes color (String) and isFilled (boolean). Include a constructor and a displayInfo() method.

Create a Circle class that extends Shape.

Circle should have an additional attribute radius (double).

Circle's constructor should call the Shape class constructor using super().

Add a method calculateArea() to Circle.

In main, create Shape and Circle objects and call their methods to demonstrate inheritance.

12: Method Overriding

Objective: Implement method overriding and understand its implications.

Tasks:

Create a Vehicle class with attributes make (String), model (String) and a method start() that prints "Vehicle starting."

Create a Car class that extends Vehicle. Override the start() method to print "Car starting with key."

Create a Motorcycle class that extends Vehicle. Override the start() method to print "Motorcycle starting with kickstart."

In main, create objects of Vehicle, Car, and Motorcycle and call their start() methods to observe different behaviors. Use the @Override annotation.

13: Polymorphism (Method Overloading and Dynamic Dispatch)

Objective: Understand compile-time and runtime polymorphism.

Tasks:

Revisit the Shape (Circle) hierarchy from Lab 11.

In the Shape class, add an overloaded method draw():

draw(): prints "Drawing a generic shape."

draw(String style): prints "Drawing a shape with style: [style]."

In Circle, override the draw() method (no parameters) to print "Drawing a Circle with radius [radius]."

In main, create a Circle object and demonstrate:

Calling Circle's draw() method.

Calling Shape's overloaded draw(String style) method on the Circle object.

Create a Shape reference pointing to a Circle object (polymorphism): Shape myShape = new Circle(...); and call myShape.draw(). Observe dynamic dispatch.

14: Abstract Classes and Methods

Objective: Implement abstract classes and understand their role in defining common interfaces for subclasses.

Tasks:

Create an abstract class Employee with attributes name (String), id (String).

Declare an abstract method calculateSalary() that returns a double.

Implement a concrete method displayDetails() that prints name and ID.

Create two concrete subclasses: FullTimeEmployee and PartTimeEmployee.

FullTimeEmployee should have an additional attribute monthlySalary and implement calculateSalary() to return monthlySalary.

PartTimeEmployee should have hourlyRate and hoursWorked and implement calculateSalary() to return hourlyRate * hoursWorked.

In main, create objects of FullTimeEmployee and PartTimeEmployee, call displayDetails(), and calculateSalary(). Demonstrate that you cannot instantiate Employee.

15: Polymorphic Arrays and Collections (Basic)

Objective: Use polymorphic arrays to store objects of different types from a hierarchy.

Tasks:

Using the Employee (FullTimeEmployee, PartTimeEmployee) hierarchy from Lab 14.

Create an array of type Employee (e.g., Employee[] employees = new Employee[3];).

Store a FullTimeEmployee object, a PartTimeEmployee object, and another FullTimeEmployee object in this array.

Loop through the employees array and for each Employee object, call displayDetails() and calculateSalary(). Observe how polymorphism ensures the correct calculateSalary() method is called for each specific employee type.

Module 4: Interfaces, Exception Handling, and Introduction to Collections (Labs 16-20)

16: Interfaces

Objective: Understand and implement interfaces for defining contracts.

Tasks:

Create an interface Playable with an abstract method play().

Create two classes: AudioPlayer and VideoPlayer.

Both AudioPlayer and VideoPlayer should implement Playable and provide their own implementation of the play() method (e.g., "Playing audio..." or "Playing video...").

In main, create objects of both players, store them in an array of Playable type, and loop through the array calling the play() method on each.

17: Exception Handling (try-catch)

Objective: Learn to handle common runtime exceptions gracefully.

Tasks:

Write a program that attempts to divide two numbers taken from user input. Use a try-catch block to handle ArithmeticException (for division by zero).

Write a program that tries to access an element beyond the bounds of an array. Use a try-catch block to handle ArrayIndexOutOfBoundsException.

Modify the previous input program to handle InputMismatchException if the user enters non-integer input.

18: Exception Handling (finally, throw, throws)

Objective: Deepen understanding of finally, throw, and throws.

Tasks:

Create a method readFile(String fileName) that attempts to open a file. Use try-catch-finally to ensure the file is closed regardless of whether an exception occurs.

Create a custom exception class InvalidAgeException (unchecked exception).

Write a method validateAge(int age) that throws InvalidAgeException if the age is less than 0 or greater than 150.

In main, call validateAge() within a try-catch block to demonstrate handling the custom exception.

19: Introduction to Collections - ArrayList

Objective: Use ArrayList to store and manage collections of objects.

Tasks:

Create an ArrayList of String to store a list of your favorite movies.

Add at least 5 movies to the list.

Print all movies in the list.

Remove one movie by name and one by index.

Check if a specific movie is in the list.

Iterate through the list using an enhanced for loop and print each movie.

20: Object Equality (equals() and hashCode())

Objective: Understand object equality and correctly override equals() and hashCode().

Tasks:

Create a class Point with private attributes x (int) and y (int).

Implement a constructor for Point.

Override the toString() method to return a string representation like "Point(x, y)".

Override the equals(Object obj) method so that two Point objects are considered equal if their x and y values are the same.

Override the hashCode() method consistent with equals().

In main, create several Point objects, including some with identical x and y values.

Demonstrate the use of equals() to compare points.

(Optional/Bonus) Add Point objects to a HashSet and observe how hashCode() impacts uniqueness (if hashCode() isn't overridden correctly, duplicate points might be added).

Targeted Application & Tools that can be used:

Java Development Kit (JDK):

Integrated Development Environments (IDEs) - IntelliJ IDEA Community Edition,Eclipse IDE for Java Developers,Apache NetBeans

Version Control System (VCS) - Git, GitHub/GitLab/Bitbucket

Text Book(s):

T1. Head First Java by Kathy Sierra and Bert Bates

T2. Java: A Beginner's Guide by Herbert Schildt T3. Core Java, Volume I—Fundamentals by Cay S. Horstmann:
Reference(s): The Object-OrientOriented Thought Process by Matt Weisfeld Java: The Complete Reference by Herbert Schildt:

VLSI Desin Basket

Course Code: ECE3455	Course Title: VLSI Architecture Type of Course: Discipline Elective & Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Logic Design, Microprocessors and Microcontrollers					
Anti-requisites	NIL					
Course Description	This course explores the architectural design principles of Very Large Scale Integration (VLSI) systems with a focus on the development of high-performance, low-power digital architectures. Students will learn about datapath design, control logic, pipelining, memory hierarchies, parallel processing architectures, and power optimization techniques. Through this course, learners will understand the critical trade-offs between speed, area, and power in VLSI systems and will apply architectural techniques to design custom processors and embedded hardware accelerators used in SoC and FPGA-based systems.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 7) Describe the design methodology and performance parameters of VLSI systems 8) Analyze architectural building blocks such as ALUs, multipliers, and memory subsystems. 9) Apply VLSI architecture concepts in real-world applications such as DSP, AI accelerators, and embedded systems. 10) Evaluate performance, power, and area trade-offs using architectural-level optimization techniques.					
Course Content:						
Module 1	Introduction to VLSI Architecture and Design Metrics	Quiz	Memory Recall based Quizzes	09 Session		
Topics: VLSI system-level design flow, Design abstraction levels: behavioral, RTL, gate-level, Performance						

metrics: delay, area, power, throughput, latency, Moore's Law and scaling trends, RTL vs. architectural design considerations				
Module 2	Datapath Architectures and Arithmetic Units	Assignment		12 Session
Topics: Design of arithmetic blocks: adders, multipliers, shifters, Signed/unsigned data operations, Carry-save, Wallace tree, Booth multipliers, Bit-slicing and array-based data paths, Control-path interaction and FSM modeling				
Module 3	Pipelining, Parallelism, and Instruction-Level Optimization	Assignment	Theoretical Understanding	14 Session
Topics: Pipelining principles and hazards, Instruction-level parallelism (ILP), loop unrolling, Superscalar architectures, VLIW (Very Long Instruction Word) architecture, Design of custom pipelined execution units				
Module 4	Memory Architectures	Assignment		10 Session
Topics: Memory hierarchy: registers, SRAM, DRAM, caches, Cache organization: direct-mapped, set associative, write policies, Memory interfacing and timing, Power reduction techniques: clock gating, operand isolation, studies: RISC-V pipeline, AI accelerator cores				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Applications: ASIC design, SoC architecture, AI and DSP processors, FPGA-based embedded systems Tools: Xilinx Vivado, Synopsys Design Compiler, Cadence Genus, ModelSim, Verilog/SystemVerilog, RTL simulation				
Text Book 5. David A. Patterson and John L. Hennessy, Computer Organization and Design – The Hardware/Software Interface, Morgan Kaufmann, 2017.				
Reference(s): Reference Books 14. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd ed., Pearson, 2003. 15. Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, Pearson, 2011. Online Resources (e-books, notes, ppts, video lectures etc.): 9. https://nptel.ac.in/courses/117106090 – NPTEL VLSI Design 10. https://www.chipverify.com – Tutorials on Verilog and architecture 11. https://ocw.mit.edu – MIT OCW Digital Design and Architecture 12. https://www.coursera.org/learn/digital-vlsi – Coursera: Digital VLSI system designPresidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: 10. 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 11. 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 12. IN-GON LEE1 , WON-SEOK OH2 , YOON JAE KIM2 , AND IC-PYO HONG , "Design and Fabrication of Absorptive/ Transmissive Radome Based on Lumped Elements Composed of Hybrid Composite Materials" , IEEE Access 2020 ,				

https://ieeexplore.ieee.org/document/9141287	
Topics relevant to "SKILL DEVELOPMENT": This course builds industry-relevant skills in RTL design, memory hierarchy understanding, low-power architecture, and processor pipeline modeling. Students gain hands-on exposure to hardware description languages and synthesis tools, preparing them for roles in ASIC design, embedded hardware acceleration, and silicon architecture teams.	
Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE3456	Course Title: ASIC Design Type of Course: Discipline Elective & Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
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 An application-specific integrated circuit (ASIC) is an integrated circuit customized for a particular use, rather than intended for general-purpose use. This course aims to foster knowledge of various ASIC architectures, ASIC design flow, issues in ASIC design and testing of ASICs and also about SOC Design					
Course Objective	The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 11) Describe architecture of programmable devices. 12) Explain programmable methodologies. 13) Relate design and implementation flow for PLDs. 14) Explain the low power design techniques and methodologies.					
Course Content:						
Module 1	Introduction to ASICS, CMOS LOGIC, ASIC Library Design	Quiz	Memory Recall based Quizzes	09 Session		
Topics: Types of ASICs - Design flow – CMOS transistors- CMOS Design rules –Combinational logic Cell Sequential logic cell - Transistor as Resistors - Transistor parasitic capacitance – Logical effort - Library cell design – Library architecture.						
Module 2	Programmable ASICS	Assignment		12 Session		
Topics: Anti fuse - Static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Xilinx I/O blocks.						

Module 3	Low Level Design	Assignment	Theoretical Understanding	14 Session
Topics: Entry: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Log				
Module 4	Silicon On Chip Design	Assignment		10 Session
Topics: Over view of physical design flow- tips and guideline for physical design- modern physical design techniques- power dissipation-low power design techniques and methodologies-low power design tools- tips and guideline for low power design.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Application Area – Facility Manager, Process Engineer , Process development designer , Facility Engineer, Process simulation Engineer. Professionally Used Software: ATHENA/SILVACO , SYNOPSIS , TCAD , VISUAL TCAD				
Text Book 6. M.J.S. Smith, —Application Specific Integrated Circuits‖, Pearson Education, 2008 .				
Reference(s): Reference Books 16. Wayne Wolf, —FPGA-Based System Design‖, Prentice Hall PTR, 2009. 17. Farzad Nekoogar and Faranak Nekoogar, —From ASICs to SOCs: A Practical Approach‖, Prentice Hall PTR, 2023 Online Resources (e-books, notes, ppts, video lectures etc.): 13. NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview 14. Udemy - https://www.udemy.com/course/pcb-design-and-fabrication-for-everyone/ 15. Coursera - https://www.coursera.org/lecture/leds-semiconductor-lasers/introduction-to-semiconductor-fundamentals-3zejs 16. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: 13. 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 14. 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 15. IN-GON LEE1 , WON-SEOK OH2 , YOON JAE KIM2 , AND IC-PYO HONG , "Design and Fabrication of Absorptive/ Transmissive Radome Based on Lumped Elements Composed of Hybrid Composite Materials" , IEEE Access 2020 , https://ieeexplore.ieee.org/document/9141287				
Topics relevant to "SKILL DEVELOPMENT": Growth mechanics and kinetics, oxidation techniques and systems, packaging design considerations -for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.				

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by	

the Academic Council	

Course Code: ECE34xx	Course Title: LOW POWER VLSI DESIGN Type of Course: Theory only	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of digital circuits like gates, flip-flops, registers, multiplexers, decoders etc. Fundamentals of Analog and Digital VLSI design. HDL Languages like Verilog / VHDL.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to appreciate the fundamentals of low power architectures and systems. The course is both conceptual and analytical in nature and needs fair knowledge of VLSI design. The course also helps to develop a broad insight into the methods used to confront the low power issue from circuit level to system level of abstraction. It also enhances student's abilities to develop a low power design architecture and analyze various parameters.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of low power VLSI design and attain EMPLOYABILITY SKILLS by using PROBLEM SOLVING.					
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 the 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	Designing and Analysis task	10 Sessions		
Topics: Introduction: Sources of Power dissipation: Dynamic Power Dissipation, Short Circuit Power, Switching Power Glitching Power. 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., Static Power Dissipation, Degrees of Freedom, Supply Voltage Scaling Approaches: Device feature size scaling, Multi-Vdd Circuits						

Module 2	Power analysis	Assignment	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, Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.				
Module 3	Low Power Design at circuit and logic level	Assignment	Design Analysis	10 Sessions
Topics: Low Power Design Circuit Level: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.				
Module 4	Leakage Power minimization Approaches, Adiabatic switching, Memory Design	Assignment/Project	Data Analysis	10 Sessions
Topics: Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. Variable-threshold-voltage CMOS (VTCMOS) approach, Multi-threshold-voltage CMOS (MTCMOS) approach, Power gating, Low power Clock Distribution, CAD tools for low power synthesis, Special Techniques: Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.				
Targeted Application & Tools that can be used: Application Area is high-performance digital systems, such as microprocessors, digital signal processors (DSPs). Professionally Used Software: Xilinx-ISE; VIVADO; Cadence-Virtuoso. Open source tools: EDA Playground; LT-Spice; Microwind.				
Project work/Assignment: 1. Case Studies: At the end of the course students will be given a topic related to Low Power VLSI Design that would have been published, as a case study. Students will be submitting a report 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:

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 a 4x4 NOR ROM with the following row content: Row[0] = 1011, Row[1] = 0110, Row[2] = 1010 and Row[3] = 1111.

Assignment 2: Sketch a transistor-level schematic of a CMOS complex logic gate that realizes (a) the function and (b) draw stick diagram of the same complex logic gate.

Textbook(s):

1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI circuit design", John Wiley & Sons Inc., 1st edition, 2000.

References:

Reference Book(s):

2. Soudris, Dimitrios, Christrian Pignet, Goutis, Costas, "Designing CMOS circuits for low power," Springer International, 2004. (1st Edition)
3. Ajit Pal, —Low-Power VLSI Circuits and Systems‖, Springer, 2015. (1st Edition)
4. A. P. Chandrakasan, R.W. Broderson, "Low Power Digital VLSI Design", IEEE Press, 1998. (1st Edition)
5. Gary K.Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 1998. (1st Edition)
6. Jan M. Rabaey, Massoud Pedram, "Low power Design methodologies", Kluwer Academic Press, 1996. (1st Edition)
7. Michael Keating, David Flynn "Low Power Methodology Manual for System-On-Chip Design" Springer Publication 2007. (1st Edition)

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

1. Lecture videos for Low Power VLSI Circuits & Systems by Prof. Ajit Pal Department of Computer Science and Engineering, 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/

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. 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
3. 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
4. Badawy, Wael, and Magdy Bayoumi. "Low power VLSI architecture for 2D-mesh

video object motion tracking." In *Proceedings IEEE Computer Society Workshop on VLSI 2000. System Design for a System-on-Chip Era*, pp. 67-72. IEEE, 2000. https://ieeexplore.ieee.org/abstract/document/844532
Topics relevant to "EMPLOYABILITY SKILLS": 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 for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Ashutosh Anand
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE3461	Course Title: VLSI Algorithms and Design Type of Course: Discipline Elective & Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Logic Design, Data Structures and Algorithms, Introduction to VLSI Design					
Anti-requisites	NIL					
Course Description	This course focuses on the algorithmic foundations and optimization techniques used in the automated design and analysis of VLSI systems. It introduces students to core computational problems in physical design automation (PDA), logic synthesis, timing analysis, floor planning, placement, routing, and testing. Students will learn about key data structures and heuristic algorithms tailored to hardware constraints, enabling the development of efficient design flows for ASICs and FPGAs. The course bridges theoretical computer science with practical aspects of silicon design and CAD tools.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: 15) Describe the computational complexity and constraints of VLSI design problems. 16) Apply graph-theoretic and geometric algorithms in layout synthesis. 17) Analyze and optimize placement, partitioning, and routing techniques. 18) Evaluate performance, area, and power trade-offs using algorithmic models.					
Course Content:						
Module 1	Introduction to VLSI Design Automation	Quiz	Memory Recall based Quizzes	09 Session		
Topics: Overview of VLSI design flow, Role of CAD tools in RTL-to-GDSII flow, Classification of VLSI design problems: NP-completeness and approximation, Graph and geometry foundations: BFS, DFS, spanning trees, grids, Data structures: segment trees, priority queues, disjoint sets						
Module 2	Partitioning, Floor planning, and Placement	Assignment		12 Session		
Topics:						

Kernighan–Lin and Fiduccia–Mattheyses algorithms for partitioning, Multi-way and hierarchical partitioning, Floor planning using slicing trees and shape functions, Simulated annealing and sequence pair representations, Standard cell and macro cell placement strategies

Module 3	Global and Detailed Routing Algorithms	Assignment	Theoretical Understanding	14 Session

Topics:
Maze routing and Lee's algorithm, Line probe, Steiner tree, and A* search, Channel and switchbox routing, Grid graphs and track assignment, Timing-driven and congestion-aware routing

Module 4	Logic Synthesis and Testing Algorithms	Assignment		10 Session

Topics:
Boolean function representation: BDDs, SOPs, factored forms, Two-level and multi-level logic optimization, Technology mapping and library binding, Test generation: D-algorithm, PODEM
Fault models: stuck-at, bridging, delay faults

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Applications: ASIC/FPGA automation, SoC integration, CAD tool development

Tools: Synopsys Design Compiler, Cadence Innovus, ABC logic synthesis tool, VPR (VLSI CAD), Python/C++ for custom algorithms

Text Book

7. Naveed A. Sherwani, Algorithms for VLSI Physical Design Automation, Springer, 2002.
8. Charles Roth and Lizy Kurian John, Digital Systems Design Using VHDL, Cengage, 2017.

Reference(s):
Reference Books

18. Sadiq M. Sait and Habib Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 1999.
19. Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, McGraw-Hill, 1994.

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

17. https://vlsicad.ucsd.edu – UCSD VLSI CAD research group
18. https://opencores.org – Open-source VLSI design resources
19. https://cadcontest.cs.nctu.edu.tw – CAD tool challenges and benchmarks
20. https://nptel.ac.in/courses/117106092 – NPTEL: VLSI Physical Design Automation

E-content:

16. 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
17. 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
18. IN-GON LEE1 , WON-SEOK OH2 , YOON JAE KIM2 , AND IC-PYO HONG , "Design and Fabrication of Absorptive/ Transmissive Radome Based on Lumped Elements Composed of Hybrid Composite Materials" , IEEE Access 2020 , https://ieeexplore.ieee.org/document/9141287

Topics relevant to "SKILL DEVELOPMENT": This course builds industry-relevant skills in RTL design, memory hierarchy understanding, low-power architecture, and processor pipeline modeling. Students gain hands-on exposure to hardware description languages and synthesis tools, preparing them for roles in ASIC design, embedded hardware acceleration, and silicon architecture teams.

Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Embedded Systems Basket

Course Code: ECE4xxx	Course Title: Software for Embedded System Type of Course: Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Before attempting this course the student should have prior knowledge of Digital Logic and Operators, some understanding of Microprocessors and/or Microcontrollers, Assembly Language Programming of any Microprocessors and/or Microcontrollers, Prior C Programming knowledge (would be an added advantage but not compulsory).					
Anti-requisites	NIL					
Course Description	This course focuses on the development of software for real-world embedded systems. Students will be exposed to various techniques for writing efficient codes for embedded products. The course will begin by giving an overview of controlling hardware systems using C programming language. In the next level use of Integrated Development Environment (IDE) tools will be undertaken for building and managing efficient programs and design. Installation of software tools as well as virtual machines, controlling of hardware kits etc. will be the key elements. To augment the learning process for independent software development students will be trained in compilation and make process by using various open-source compilers and tools such as GNU toolchain GNU, Git version control, Linux, Virtual Machines etc. Additionally, concepts like memory management; device driver development, compilers and debuggers, timers and interrupt systems, interfacing of devices, communications and networking in embedded systems will make students ready for industry.					
Course Objective	The objective of the course is to familiarize the learners with the software for embedded systems and attain SKILL DEVELOPMENT through PARTICPATIVE LEARNING					

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

Summarize the concepts to develop software for real time embedded systems.

Write efficient programs with IDE tools for embedded systems.

Demonstrate various programming steps using open-source compilers and tools for embedded software development.

Explain various concepts of memory management, device drivers, and timers and interrupt systems, interfacing of devices, communications and networking in embedded systems.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Embedded Systems Software Development</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>7 session</td></tr>
<tr><td colspan="5">Topics:

Review of Embedded Systems and Application Areas, Fundamentals of Software Engineering and Development Processes, Embedded Software - Safety, Security and Quality, Introduction to Embedded Software Modelling, Context Diagrams, State Charts / Finite State Machines (FSMs),.</td></tr>
<tr><td>Module 2</td><td>C-Programming for Embedded Systems</td><td>Assignment / Quiz</td><td>Programming</td><td>8 session</td></tr>
<tr><td colspan="5">Topics:

Review of modeling languages for Embedded Software development, C-Programming Review, Programming ARM Controllers using C – Conditional Statements, Loop Statements, debugging, single stepping, breakpoints, pointers and data structures, variables, numbers and parameter passing.</td></tr>
<tr><td>Module 3</td><td>Memory Management and Device Driver Concepts</td><td>Assignment</td><td>Analysis and Verification</td><td>17 session</td></tr>
<tr><td colspan="5">Topics:

Introduction to Memory Organization, Memory Architectures, Memory Segments, Data Memory, Special Keywords (Const, Extern & Static), The Stack, The Heap, Code Memory, Practice on Memory Manipulation Software, Incorporate Memory Manipulation Software into the build system and Evaluation of some Test Functions. Linux - Scripting and Configuration, Kernel Building, Building Libraries and Utilities, Generic Device Driver Development Concepts, Linux Device Drivers.</td></tr>
<tr><td colspan="5">Project Work/Assignment:</td></tr>
<tr><td colspan="5">1.Case Studies: At the end of the course students will be given ‘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 to the library resources and write a report on their</td></tr>
</table>

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 topic. They will have to explain/demonstrate the working and discuss the applications for the same.

4. Project Assignment:

Assignment 1:

Recently there have been lot of controversies over use of Electronic Voting Machine (EVM) Systems in elections. You have been asked to design an "EVM System" to be used in elections. The system will have additional facility to webcast the voting process live to a central station using Wi-Fi/3G/4G connection by using a high-resolution camera and/or tablet (as of now avoid VVPAT facility). Draw a FSM diagram considering various states, inputs and Outputs.

Assignment 2:

Consider the figure shown below showing the layout of an Embedded System to be designed using the TM4C123x/129x microcontroller. Write a device driver for the individual modules shown such as for stepper motor control, dc motor control, timer and sensing inputs both digital as well as analog.

Text Book(s):

Joseph Yiu, “The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors,” 3rd Edition, Newnes.

Reference(s):

Reference Book(s):

Michael Barr and Anthony Massa, “Programming Embedded Systems with C and GNU Development Tools,” O’Reilly.

Haring D.D. et al., “Embedded Software Development With C,” Springer.

Jane W S Liu, “Real – Time Systems”, Prentice Hall, 2000.

Class Notes (CN).

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

Video lectures on “Embedded System using Arm” by Prof. Dr.Indranil Sen Gupta, IIT KGP Lecture 01: Introduction to Embedded Systems - YouTube

Lecture series on Embedded Systems by Dr.Santanu Chaudhury,Dept. of Electrical Engineering, IIT Delhi . For more details on NPTEL visit http://nptel.ac.in

E-content:

Camposano, R., & Wilberg, J. (1996). Embedded system design. Design Automation for Embedded Systems, 1(1), 5-50. Embedded system design | SpringerLink

Ryu, S., & Kim, S. C. (2020). Embedded identification of surface based on multirate sensor fusion with deep neural network. IEEE embedded systems letters, 13(2), 49-52. Embedded Identification of Surface Based on Multirate Sensor Fusion With Deep Neural Network | IEEE Journals & Magazine | IEEE Xplore

Topics relevant to “SKILL DEVELOPMENT”: Introduction to Embedded Systems, C-Programming for Embedded Systems. Memory management concepts for C programming for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Aruna Dore
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: ECE3416	Course Title: REAL TIME SYSTEMS Type of Course: Discipline Elective VLSI and Embedded Systems Basket Theory	L- T-P- C	3	0	0	3

Version No.		1.0
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		The objective of the course is to familiarize the learners with the concepts of Real Time Systems and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.

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	Assignment/Quiz		System Design	10 classes

	Development Methodologies & Intertask Communication			Task and Analysis	

	Topics: Foreground/Background System. Yourdon Methodology, Ward and Mellor Method, Hately and Pirbhai Method, Buffering data – Time relative Buffering- Ring Buffers – Mailboxes – Queues – Critical regions – Semaphores – other Synchronization mechanisms – deadlock – priority inversion – process stack management – run time ring buffer .
	List of Laboratory Tasks: Nil
	Targeted Application & Tools that can be used: The students will be able to find a career in various domains such as Embedded systems, Smart Home automation and security, Power Generation and Robotics, Automotives. Professionally Used Software: CODE COMPOSER STUDIO, MATLAB
	Text Book(s): Stuart Bennet, "Real-Time Computer Control", 2nd Edn. Pearson Education. "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): NPTEL: https://onlinecourses.nptel.ac.in/noc21_cs98/preview Udemy: https://www.udemy.com/course/real-time-systems https://www.notesforgeeks.in/2021/08/ec8791-embedded-and-real-time-systems-syllabus-2017-regulation.html https://nielit.gov.in/chennai/sites/default/files/Chennai/ED500-Syllabus.pdf https://www.rejinpaul.com/2021/06/ec8791-embedded-and-real-time-systems.html https://www.cse.iitb.ac.in/~krithi/courses/684/ts-Sep-2004.pdf Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

	E-Content: 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 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 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 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 Design and Operation of ETA, an Automated Ellipsometer P. S. Hauge and F. H. Dill, "Design and Operation of ETA, an Automated Ellipsometer," in IBM Journal of Research and Development, vol. 17,no.6,pp.472-489,Nov.1973,doi:10.1147/rd.176.0472. https://ieeexplore.ieee.org/document/5391322
	Topics relevant to “EMPLOYABILITY SKILLS”: Data Transfer Techniques, Compilation of Modular Programs, Operating systems and hardware support for real-time applications, Priority Structures and Task Management - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs.ANNAPURNA.H.S
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the	Meeting No. 16th , Dated 23/10/2021

Academic Council	

Course Code: ECE3417	Course Title: DSP Processors Type of Course: Discipline Elective-Signal Processing Basket	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of simple high school math on trigonometry, complex numbers, signals and systems, Digital signal Processing algorithm computations, and a little familiarity with programming especially numerical computation.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of DSP processors. The course imparts the knowledge of basic DSP concepts and number systems to be used, different types of conversion errors. The course emphasizes the architectural differences between DSP and General purpose processor.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of DSP Processors to improve the learners' Employability Skills by Participative Learning.					

Course Outcomes	On successful completion of this course the students shall be able to: Understand the basics of Digital Signal Processing and transforms. Able to distinguish between the architectural features of General purpose processors and DSP processors. Understand the architectures of TMS320C54xx devices and Acquire knowledge about various addressing modes Discuss about various memory and parallel I/O interfaces			
Course Content:				
Module 1	Introduction To Digital Signal Processing	Quiz	Memory Recall based Quizzes	12 session
Introduction to Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. Review of Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), linear time-invariant systems, Digital filters, Decimation and interpolation. Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors				
Module 2	Architectures for Programmable DSP Devices and Pipelining	Assignment / Quiz	Programming and Simulation task	12 session
Topics: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Memory space, Program Control, instructions and Programming, On-Chip Peripherals, Interrupts, Pipeline Operation.				
Module 3	Implementations of Basic DSP Algorithms	Assignment	Analysis and Verification	10 session
The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX				

Module 4	Interfacing Memory And I/O Peripherals	Assignment	Analysis and Verification	10 session

Topics:

Memory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct memory access (DMA).

Targeted Application & Tools that can be used:

Code Composer studio with C / C++ compiler for TI C6xxx DSPs, can be used for implement DSP algorithms.

Text Book(s):

Avtar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004

.B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications‖, Tata

Reference(s):

Reference Book(s):

Jonatham Stein, Digital Signal Processing‖, John Wiley, 1st Edition, 2000. 2. Sen M. Kuo & WoonSergGan,

Digital Signal Processors Architectures, Implementation and Application‖, Pearson Practice Hall, 1st Edition, 2013

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

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

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:

Gustavo Ruiz, Juan A. Michell, Design and Architectures for Digital Signal Processing. 2013, https://www.intechopen.com/books/3158

"Quad DSP board gives processor-hungry applications a performance boost", Aircraft Engineering and Aerospace Technology, Vol. 71 No. 5. https://doi.org/10.1108/aeat.1999.12771ead.002 https://www.emerald.com/insight/content/doi/10.1108/aeat.1999.12771ead.002/full/html

Topics relevant to “EMPLOYABILITY SKILLS”: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Mrs. KEHKESHAN JALALL S
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3418	Course Title: FPGA Design for Embedded Systems Type of Course: Discipline Elective & Theory only	L- T-P- C	3	0	0	3
Version No.		1.0				
Course Pre-requisites		Basics of Digital logic and Digital design				
Anti-requisites		NIL				
Course Description		The purpose of this course is to enable the students to understand the basics of FPGA. This course aims to build knowledge on understanding programmable architectures and configuring them for different applications. The course also help student learn about the Verilog programming structures and modelling types				

		which can be used for digital system design and help in building of an over-all concept for an application which can be tested on FPGA interfaced with various other hardware's.
Course Objective		This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using FPGA Board
Course Outcomes		On successful completion of this course the students shall be able to: 1. Understand the basic concepts of FPGA. 2. Apply embedded system concepts with appropriate FPGA based on applications 3. Write Verilog code for combinational and sequential logics CO4: Students can design a communication module using Verilog. 4. Design a motor control module using Verilog
Course Content:		

Module 1	FPGA Architecture And Overview	Quiz		Memory Recall based Quizzes	9 Sessions
	Topics: Embedded system design flow - Robot Control System - Digital Design Platforms - Microprocessor based Design - Single-chip Computer/Microcontroller-based Design - Application Specific Standard Products (ASSPs) - Design Using FPGA - robotic rover application - FPGA Devices - FPGA and CPLD – Architecture of a SPARTAN-3ETM FPGA - Floor Plan and Routing - Timing Model for a FPGA - FPGA Power Usage.				
Module 2	Embedded System Design	Assignment		Theoretical Understanding	10 Sessions
	Topics: FPGA-based Embedded Processor - Design Re-use Using On-chip Bus Interface - Creating a Customized Microcontroller - Robot Axis Position Control - FPGA-based Signal Interfacing and Conditioning – Motor Control Using FPGA- Case Studies for Motor Control -Prototype Using FPGA- FPGA Design Test Methodology				
Module 3	Verilog Constructs	Assignment		Theoretical Understanding	10 Sessions

	Topics: VLSI Design flow- behavioral style, the dataflow style, and structural style - Data types - Constants - Assignment Statement - Operators - Conditional Expressions - Statement types - Vector operations – Bit selects - Functions - Gate level modeling.				
Module 4	Verilog Modeling Building FPGA projects	Assignment		Programming assignment	13 Sessions
	Topics: Design and test a Binary Coded Decimal Adder, Design and test a PWM Circuit, with verification by simulation. Design and test an ADC circuit, using Quartus Prime built-in tools to verify your circuit design. Enhance and test a working design, using most aspects of the Quartus Prime Design Flow and the NIOS II Software Build Tools (SBT) for Eclipse.				
	List of Laboratory Tasks: Nil				
	Targeted Application & Tools that can be used: Application Area – Video imaging, Automotive computing, Aerospace applications. Signal processing, Medical devices Professionally Used Software: PyCharm,Qt Creator,MATLAB,Eclipse,WebStorm				
	Project work/Assignment:				
	1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 2.Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. 3. Project Assignment- Implement various digital circuits in Verilog and verify the same on FPGA board., Write a report on the research article given., Explore the robotic application of embedded system with a research article and verify the coding done in the same.				

Text Book

Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays" Springer-Verlag London Limited, 2009

John F. Wakerly, Digital Design Principles and Practices", Pearson Education, Asia, III Edition, 2003.

References

Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press,2011.

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 :

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

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

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

	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: ECE3419	Course Title: Developing Secure Embedded Systems Type of Course: Discipline Elective Theory	L- T-P-C	3	0	0	3

Version No.		1.0
Course Pre-requisites		Basic understanding of Microprocessor 8085, Microcontroller 8051. Basic knowledge of VLSI, Assembly language programming and c programming.
Anti-requisites		NIL

Course Description		The course focuses on design, implementation and explore hardware and software security measures design using appropriate techniques and tools and to develop an ability to understand comprehensively the technologies and techniques underlying in building an embedded solution in a trustful and secure environment.
Course Objective		This course is designed to improve the learners' EMPLOYABILITY SKILLS by using PROBLEM SOLVING methodologies of secure embedded systems.
Course Outcomes		On successful completion of this course the students shall be able to: (1) Explain the origin and characteristics of Embedded Systems. (2) Apply various techniques to secure an Embedded Systems. (3) Demonstrate various security vulnerabilities and its solutions (4) Employ various techniques to deploy and secure Embedded systems.
Course Content:		

Module 1	Embedded System Primer	Quiz		Memory Recall based Quizzes	10 Classes
	Topics: Embedded system processor- PIC, ARM- Programming input and output, Components for embedded system, Models of program, Assembly, linking, loading, Compilation techniques, Program optimization.				
Module 2	Layers of embedded system	Assignment / Quiz		Simulation Based	10 Classes
	Topics: Embedded Design life cycle, Embedded System modelling, Layers of an Embedded System – hardware layer – Application layer – Software Layer – middleware. EDLC Approaches, Interfaces to the external world. FPGA- The Role of FPGAs, FPGAs types, FPGAs vs Custom VLSI, Fine - Grained and Course - Grained Reconfigurable Architecture, Case Studies.				
Module 3	Introduction to security and tools	Assignment		Simulation Based	12 Classes
	Topics: Security properties (confidentiality, integrity and availability), security vulnerabilities, threats and attacks, security models, policies and mechanisms, Encryption Techniques, Basic notions of security protocol. Block Ciphers - DES, AES, Blowfish, modes of operation, Stream Ciphers-RC4, Linear and				

	Differential cryptanalysis					
Module 4		Security in Embedded Systems	Assignment		Design Based	08 Classes
	Topics: Cryptography, Trusted computing, FPGA Flexibility, Trusted -untrusted zone isolation, Physical attack protection, Access control mechanism, Incentive based Trust model deployment for securing Embedded system and prevention of DDoS.					
	Project work/Assignment:					
	Project Assignment: 1. A systematic review of future trends in security and trust models in IoT. 2. Secure WEB-Deployment using Embedded Systems 3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done. 4. Students will be made into group and given the programming assignment at the end of each module. Students need to use Embedded Development Kits for these assignments. Tools: Kiel C5 Raspberry Pi					
	Textbook(s): Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition, Press, 2016. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016. Reference Books: 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. Zhu Y. Embedded Systems with ARM® Cortex-M3 Microcontrollers in Assembly Language and C. E-Man Press; 2014. Wolf W. FPGA-based system design. Pearson education; 2004 Jun 15. E-content: SEnSE – An Architecture for a Safe and Secure Integration of Safety-Critical Embedded Systems https://ieeexplore.ieee.org/document/8555740 Design and Implementation of Secure Embedded Systems Based on Trustzone https://ieeexplore.ieee.org/document/4595549					

	High-Security System Primitive for Embedded Systems https://ieeexplore.ieee.org/document/5368926 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.): Free online self-paced course :- https://bcourses.berkeley.edu. Online notes :- https://mitpress.mit.edu/books/internet-things NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html Online ppts :- https://www.upf.edu/pra/en/3376/22580 Online ppts:- https://www.macs.hw.ac.uk/~dwcorne/Teaching/introdl.ppt https://www.udemy.com/course/embedded-electronics-bootcamp-from-bit-to-deep-learning/ https://nptel.ac.in/courses/106105159 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:	Course Title:	L-T-P-C				
ECE3420	Introduction to Embedded Machine Learning		3	0	0	3

	Type of Course: General Basket Theory only					
Version No.		2.0				
Course Pre-requisites		Comprehension of concepts/logics in Machine and Deep Learning Algorithms. Basics of Embedded Systems. Basics of Python programming for Machine and Deep Learning Algorithms.				
Anti-requisites		NIL				
Course Description		This course aims at provide introduction of an emerging field embedded machine learning. This course gives best possible insight of deploying machine learning applications on embedded systems using TinyML.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of Introduction to Embedded Machine Learning and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.				
Course Outcomes		On successful completion of this course the students shall be able to: Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. Demonstrate the importance of VHDL in real time applications. Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. Analyze the developed artificial intelligence based VHDL code for power, area and delay using the FPGA device				
Course Content:						
Module 1	Overview of Machine Learning Algorithms		Quiz	Memory Recall based Quizzes		14 session
	Supervised Learning, Regression- Linear Regression, Ridge Regression, LASSO, and Classifications of Supervised Learning: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, Perceptron, Logistic Regression, Unsupervised Learning- K-means Clustering, and PCA.					
Module 2	Overview of Embedded Devices for Machine Learning Algorithms		Assignment / Quiz	Programming and Simulation task		12 session
	RISC and CISC Architectures, Introduction to ARM® Architecture and ARM® Cortex™-M TM4C123X processor, Comparing ARM® Cortex™-M TM4C123X processor with TM4C129X architecture, FPGA.					
Module 3	TinyML		Assignment	Programming		19 session

	Fundamentals of TinyML, Need of TinyML, Advantages, Deploying TinyML, Factors to be considered while deploying TinyM.

Targeted Application & Tools that can be used:

JOBS-

Execute a lead role for the design, development, and verification of real-time machine learning algorithms for innovative power tools.

A state-of-the-art field that brings the performative power of ML to shrink deep structured earning networks to fit on tiny hardware.

Implement machine learning algorithms in embedded environments.

Manage the development of data collection methods, test plans/procedures and test cases for training, evaluation, and verification of machine learning algorithms.

TOOLS-

Python (NumPy, Pandas, sklearn, xgboost, TensorFlow, keras, etc.) MySQL, Snowflake, GCP/AWS and Tableau Java.

Text Book(s):

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

Pete Warden, Daniel Situnayake, “TinyML”, 1st Edition, O'Reilly Media, Inc.

Reference Book(s):

Mano, M. Morris and Ciletti Michael D., “Digital Design”, 5th Edition, Pearson Education, 2020.

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

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.):

Harward University Course on “TinyML”

https://pll.harvard.edu/course/fundamentals-tinyml?delta=0

NPTEL Course on “An Introduction to Artificial Intelligence” by Prof. Mausam, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs56/preview

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:

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

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

Tarek Belabed, Maria Gracielly F. Coutinho , Marcelo A. C. Fernandes , Carlos Valderrama Sakuyama , and Chokri Souani, “User Driven FPGA-Based Design Automated Framework of Deep Neural Networks for Low-Power Low-Cost Edge Computing”, IEEE Access, Volume 9, 2021, pp: 89162 – 89180. https://ieeexplore.ieee.org/document/9458248

Shuai Li, Yukui Luo, Kuangyuan Sun, Nandakishor Yadav, and Kyuwon Ken Choi, “A Novel FPGA Accelerator Design for Real-Time and Ultra-Low Power Deep Convolutional Neural Networks Compared With Titan X GPU”, IEEE Access, Volume 8, 2020, pp: 105455 – 105471. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9108269

Topics relevant to “EMPLOYABILITY SKILLS”: Classifications of Supervised Learning: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, TM4C123X processor, Deploying TinyML - 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: ECE3421	Course Title:Deep Learning using FPGA Type of Course: Program Core Theory			L-T-P-C	3	0	0	3
Version No.		1.0						
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		The objective of the course is to familiarize the learners with the concepts of Machine Learning and Deep Learning using FPGA and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes		On successful completion of this course the students shall be able to: Distinguish between Machine Learning and Deep Learning algorithms for classification, regression and identification. Demonstrate the importance of VHDL in real time applications. Apply the concept of ML and DL algorithms for classification and Identification using the developed synthesizable VHDL code. 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, and 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	Assignment / Quiz		Programming and Simulation			12	

	Design		task		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				
	Text Book(s): Deisenroth, Faisal and Ong, “Mathematics for Machine Learning”, Cambridge University Press, 1st Edition, 2020. Link: https://mml-book.github.io/book/mml-book.pdf 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): Mano, M. Morris and Ciletti Michael D., “Digital Design”, 5th Edition, Pearson Education, 2020. Oliver Theobald , “Machine Learning For Absolute Beginners: A Plain English Introduction”, 2nd Edition, The author, 2017. Andrew W. Trask, “Grokking Deep Learning”, 1st Edition, Manning Publications, 2019. Jayaram Bhasker, “A VHDL Primer”, 3rd Edition, AT&T Publcaitions, 2003. Online Resources (e-books, notes, ppts, video lectures etc.):					

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

NPTEL Course on “An Introduction to Artificial Intelligence” by Prof. Mausam, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs56/preview

NPTEL Course on “Deep Learning” by Prof. Sudarshan Iyengar & Prof.Mitesh M. Khapra , IIT Madras, https://onlinecourses.nptel.ac.in/noc19_cs85/preview

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

E-content:

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

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

Tarek Belabed, Maria Gracielly F. Coutinho , Marcelo A. C. Fernandes , Carlos Valderrama Sakuyama , and Chokri Souani, “User Driven FPGA-Based Design Automated Framework of Deep Neural Networks for Low-Power Low-Cost Edge Computing”, IEEE Access, Volume 9, 2021, pp: 89162 – 89180. https://ieeexplore.ieee.org/document/9458248

Shuai Li, Yukui Luo, Kuangyuan Sun, Nandakishor Yadav, and Kyuwon Ken Choi, “A Novel FPGA Accelerator Design for Real-Time and Ultra-Low Power Deep Convolutional Neural Networks Compared With Titan X GPU”, IEEE Access, Volume 8, 2020, pp: 105455 – 105471. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9108269

Topics relevant to “EMPLOYABILITY SKILLS”: K-NN, Decision Tree, Naive Bayes, Support-Vector Machines, Machine Learning based Regression using VHDL, Neural Network based Classification and Regression using VHDL -for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Joseph Anthony Prathap,
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

Communication Basket

Course Code: ECE3423	Course Title: Information Theory and Coding Type of Course: Program Core Basket Theory only	L- T-P- C	3	0	0	3
Version No.	1.0					
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 errorcontrol 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.Thiscourse 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 to familiarize the learners with the concepts of Information Theory and Coding and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.					
Course Outcomes	On successful completion of this course the students shall be able to: Discuss the concept of dependent and independent source, measure of information, Entropy, rate of information and order of a source. Apply the information source using Shannon encoding, Shannon Fano, encoding and Huffman encoding algorithms. Analysis of the continuous and discrete communication channels using input, output and jointprobabilities. Analysis of a codeword comprising of the check bits computed using linear blockcodes, cyclic codes and convolutional codes.					
Course Content						
Module 1	Introduction to Information	Assignment/Quiz	Numerical/ Memory recall	10		

	Theory		based	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				
Text Book(s): Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007 Reference(s):				

Digital Communications – Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058.

Information Theory and Coding-by Dr. J. S. ChitodeTechnical Publications,First edition 2021.

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

Video lectures on" Source coding theorem" by Prof: SN Merchant, IIT Bombayhttps://nptel.ac.in/courses/117101053

Videos on Entropy, Mutual Information, Conditional and Joint Entropyhttps://www.digimat.in/nptel/courses/video/108102117/L02.html

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

E-content:

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

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

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

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 "SKILL DEVELOPMENT": Information content of message, Markov Statistical Model, Source Coding, Channel Capacity, Error Control Coding for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3424	Course Title: Satellite Communication Type of Course: Discipline Elective & Theory Only.	L- T-P- C	3	0	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	The objective of the course is to familiarize the learners with the concepts of Satellite Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: Explain the fundamentals of Satellite Communication Apply the concept of Satellite Communication Link Budget. Illustrate the different parts of Satellite including On Board & Earth Segment. 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	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	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	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 "EMPLOYBILITY": Design of spade systems, space link budget estimation and design of pico satellite for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING

Techniques. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Dr.M.S Divya Rani Mrs. Annapurna
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3425	Course Title: Wireless Communication and Networks Type of Course: Discipline Elective, Data Transfer Technologies Basket Theory Only	L- T-P- C	3	0	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: Apply cellular concepts for reducing interference in mobile communication Distinguish various multiple access techniques along with area of its application Classify the various existing WLAN and WPAN network topologies

		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 Techniques		Project	Small hardware based	08 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], C2 = [1,-1,-1,1], C3 = [-1,1,1,1], C4 = [-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.): https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT https://nptel.ac.in/courses/112/105/112105249/ https://www.intechopen.com/chapters/66880 Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: (Presidency University E-resources) https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications https://www.intechopen.com/books/5408 https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/ 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: ECE3426	Course Title: Radar Engineering Type of Course: Discipline Elective & Theory only	L-T-P-C	3	0	0	3

Version No.		2.0
Course Pre-requisites		Basic concepts of analog modulation anddemodulation schemes and probability theory
Anti-requisites		NIL
Course Description		This is an advanced research-oriented course designed for undergraduate students. Thiscourse will enablestudents' knowledge towards detection and tracking of radar signals. The course emphasizes on working, analysis and design of Radar wireless communication system. Additionally, this course will create a foundation for future courses such as optical Communication and Free Space Wireless Communication system.
Course Objective		The objective of the course is to familiarize the learners with the concepts of Radar Engineering and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING
Course Outcomes		On successful completion of this course the students shall be able to: 1: Explainthe basic principle of RADAR System. 2: Solve the RADAR Equation and to calculate Transmitter power. 3: Discussthe working principle of CW and Frequency Modulated Radar. 4: Compare the principlesof MTI and Pulse Doppler Radar.

Course Content:					
Module 1	Basics of Radar	Quiz		Memory Recall based Quizzes	10 Sessions
	Topics: Basics of Radar: Introduction, Maximum Unambiguous Range, Radar Waveforms, Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power. Simple form of the Radar Equation, Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar.				
Module 2	The Radar Equation	Assignment / Quiz		Comprehension based Quizzes and assignments	9 Sessions
	Topics: The Radar Equation: Prediction of Range Performance, Detection of signal in Noise, Minimum Detectable Signal, Receiver Noise, SNR, Modified Radar Range Equation, Probability of Detection, Radar Cross Section of Targets.				
Module 3	MTI and Pulse Doppler Radar	Assignment		Comprehension based Quizzes and assignments; simulation with MATLAB	10 Sessions
	Topics: MTI and Pulse Doppler Radar: Introduction, Principle, Doppler Frequency Shift, Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler, MTI Radar with – Power Amplifier				
Module 4	Tracking Radar	Assignment		Project implementations in software, batch wise presentations	10 Sessions
	Topics: Tracking Radar: Role of the radar tracker,-Plot to track association, Track initiation, Track maintenance, Track smoothing Types of Tracking Radar Systems- Lobe switching, conical scan, Alpha-beta tracker, Kalman filter, Multiple hypothesis tracker (MHT), Interacting multiple model (IMM)				
	List of Laboratory Tasks: Nil				

	Targeted Application & Tools that can be used: Targeted Applications: Data analytics,Automatic machine translation, object detection etc. Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox
	Project Work/Assignment:
	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 Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. Project Assignment:- Implementation of various concepts in from 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 : 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 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 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 Said Mikki, dept. of ECECS, University of New Haven, West Haven, CT, USA,2018;Quantum Antenna Theory for Secure WirelessCommunications. file:///C:/Users/Admin/Downloads/Quantum_Antenna_Theory__EuCap2020_%20(1)%20(1).pdf
	Topics relevant to “EMPLOYABILITY”: Tracking Radar, Applications of Radar, Power and operating frequency for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Ashwini B
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: ECE3427	Course Title:RF Engineering Type of Course: Discipline Elective Data Transfer technology Basket & Theory only	L-T-P-C	3	0	0	3
Version No.		2.0				
Course Pre-requisites		To succeed in this course the student should be comfortable with basic concepts of Analog and Digital Communication courses. Thebasic analog and digital modulationtechniques needed to translatesignal from original frequency to a specified RF frequency. Multiple Access techniques are used to extend the RF communication for accommodating multiple users.				
Anti-requisites		NIL				
Course Description		The course is designed for undergraduate students to introduceRF components and architecture with applications. This course will enable the students to classify different active and passive components with design and noise considerations. Thiswill also enable the students to seek				

		employment opportunities, research and development activitiesindesign of RF control circuit and various systemarchitectures.
Course Objective		The objective of the course is to familiarize the learners with the concepts of RF Engineering and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING
Course Outcomes		On successful completion of this course the students shall be able to: 1)Discuss the importance of RF design and its applications. 2) Classify active RF devices and noise considerations. 3) Apply the concepts of RF engineering in RF control circuits. 4)Summarize various radio frequency architectures.
Course Content:		

Module 1	RF system-Basic architecture	Assignment		Programming and simulation Task	9 Sessions
	Topics: Introduction, Importance of using Radio frequency design, Applications. RF behavior of passive Components-Resistors, Capacitors, Inductors. Transmission line analysis Parallel RLC tank, Series RLC networks, Impedance Matching, Pi match, T match.				
Module 2	Active RF components	Assignment		Programming and Simulation Task	10 Sessions
	Topics: RF diodes, Bipolar junction transistors, RF Field Effect transistor, Metal Oxide Semiconductor Transistors, High Electron Mobility Transistors, Semiconductor Technology Trends				
Module 3	RF Transistor amplifier and Mixer Design	Project Assignment		Programming Task	9 Sessions
	Topics: Amplifier power relations, Broadband High power and Multistage Amplifiers. Basic Characteristics of Mixers, Frequency domain considerations, Single ended Mixer design, Single and double balanced mixer, Integrated active mixer, Image reject Mixer				
Module 4	TRANSCEIVER ARCHITECTURES	Assignment		Data collection and analysis	10 Sessions
	Receiver Architectures: Basic Heterodyne Receivers, Modern Heterodyne Receivers, Direct-Conversion Receivers, Transmitter Architectures:Direct-ConversionTransmitter,Modern Direct-				

	Conversion Transmitters, Heterodyne Transmitters, OOK Transceivers
	Targeted Application & Tools that can be used: Applications: Radar Communication, Satellite Communication, Future generation network design Tools: Matlab/Simulink
	Project work/Assignment:
	1.Case Studies: At the end of the course students will be given a 'real-world' application as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. Project Assignment:Design auser friendly interface for the fast access to control high voltage electrical circuit operations using RF technology. Assignment 1: Design, Visualize and compare matching network for one port load using Simulink. Assignment2: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.
	Textbooks: 1. Behzad Razavi , " RF Microelectronics ", Pearson Education ,6th Edition 2. Reinhold Ludwig,GeneBogadanov ,"RF Circuit design,Theory and Applications", Pearson India, 2011,2nd Edition Digital Reference(s) 3.ebook:https://www.atnf.csiro.au/people/Tasso.Tzioumis/sms2014/presentations/Clegg(RF_Engineering).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: Ajinkya C Bapat1, Sonali U Nimbhorkar, Department of Computer Science and Engineering, G.H. Raisoni College of Engineering, Nagpur, RFID Based Object Tracking System Using Collaborative Security Protocol,DOI 10.4010/2016.943 ISSN 2321 3361 © 2016 IJESC,Researcharticle,Volume 6,Issue no.4 https://ieeexplore.ieee.org/abstract/document/8465897 Jasmine JoseDepartment of Electronics and Telecommunication Engineering, Don Bosco Institute of Technology, Mumbai, India, Sherin George; Lydia Bosco; Juliet Bhandari; Freda Fernandes; Ashwini Kotrashetti,A review of RF energy harvesting systems in India,International Conference on Technologies for Sustainable Development (ICTSD),2015 https://ieeexplore.ieee.org/document/7095838 John Walker; Daniel Myer; Frederick Raab; Chris Trask,Classic Works in RF Engineering: Combiners, Couplers, Transformers, and Magnetic Materials, Artech https://ieeexplore.ieee.org/document/9100964
	Topics relevant to "EMPLOYABILITY": Transceiver Architectures for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Mrs AKSHATHA K
Recommended by the Board of Studies on		15th BOS held on28/07/2022
Date of Approval by the Academic Council		Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3428	Course Title: Wireless Adhoc Networks Type of Course: Discipline Elective	L-T- P- C	3	0	0	3
Version No.	1.0					
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: Explain fundamental principles of Ad-hoc Networks Discuss a comprehensive understanding of Ad-hoc network protocols Outline current and emerging trends in Ad-hoc Wireless Networks Analyze energy management in ad-hoc wireless networks.		
Course Content:			
Module 1	MAC Protocols	Assignment / Quiz	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	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	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	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 Tc is the control packet transmission propagation delay, Tw 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 Tc is the control packet transmission propagation delay, Tw 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):

Roy Blake, “Wireless Communication Technology”, First Edition CENGAGE, 2012

Jagannathan Sarangapani, “Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control” Second Edition CRC Press.

Ozan K. Tonguz and Gianguigi Ferrari: Ad-hoc Wireless Networks, John Wiley, 2007.

Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du: Ad-hoc Wireless Networking, Kluwer Academic Publishers, 2004.

C.K. Toh: Ad-hoc Mobile Wireless Networks- Protocols and Systems, Pearson Education, 2002

Online and Web resource (s):

Archive.cone.informatik.uni-freiburg.de/.../lecture/.../MANET-01.ppt

www.rimtengg.com/coit2007/proceedings/pdfs/122.pdf

people.cs.vt.edu/~irchen/6204/.../lecture4-mobile-ad-hoc-networks

https://nptel.ac.in/courses/106/105/106105160/

https://www.coursera.org/lecture/internet-of-things-history/sensor-networks-n-to-1-iOmzK

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

E-Content:

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.

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.

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

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: ECE3429	Course Title: Optical Communication Type of Course: Discipline Elective Theory only	L- T-P- C	3	0	0	3
Version No.	2.0					

Course Pre-requisites		Basic concepts of electronic devices, digital modulation and demodulation schemes, analog modulation and demodulation schemes, probability theory.
Anti-requisites		NIL
Course Description		The purpose of this course is to enable the students to learn the basic principle of optical fiber communication and also understand the transmission characteristics and losses in a wireless communication system. The course will act as a harbinger for exponentially growing modern communication systems. The course emphasizes on working, analysis and design of wireless communication system. Additionally, this course will create a foundation for future courses such as Radar Communication and Free Space Communication etc.
Course Objective		The objective of the course is to familiarize the learners with the concepts of Optical Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.
Course Outcomes		On successful completion of this course the students shall be able to: Explain the basic concepts of optical Engineering Apply the active, passive devices and optical amplifiers in optical wireless networks. Analyze an optical wireless communication system. Apply advanced concepts of optical Engineering to design and develop more efficient next generation optical wireless communication systems.
Course Content:		

Module 1	Introduction to optical wireless communication systems	Quiz	Memory Recall based Quizzes		10 Sessions
	Topics: Wireless Access Schemes, Brief History of OWC, OWC/Radio Comparison, WC Application Areas, Safety and Regulations, OWC Challenges.				
Module 2	Fluctuation Theory	Assignment	Design oriented		10 Sessions
	Topics: Scintillation Theory-Plane Wave Model, Scintillation Theory-Spherical Wave Model, Wave ModelDistribution Models for the Irradiance[introduction].				

Module 3	Modulation Techniques	Assignment	Design Analysis		10 Sessions
	Topics Introduction, Analogue Intensity Modulation, Digital Baseband Modulation Technique Pulse Position Modulation, On–Off Keying.				
Module 4	OPTICAL RECEIVER	Assignment	Application based analysis		9 Sessions
	Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver operation, Analog receivers.				
	Targeted Application & Tools that can be used: Tools: Matlab				
	Project work/Assignment: Project Assignment: 1. Create a simple network model with multiple scenarios, collect statistics on network performance through the use of simulation tools, analyse statistics and draw conclusions on network performance. 2. Establish aFree space optical communication link. 3. Compare the Bit Error Rate for various weather conditions.				
	Text Book 1.Gerd Keiser, “Optical Fiber Communications” McGraw-Hill, 5th Edition, 2013				
	References G.P Agrawal, Fiber Optic Communication Systems, Wiley, ISBN 0470505117 R.G feller and U. Bapst. Wireless in-house communication via diffuse infrared radiation, SPIE Press S. Hranilovic. Spectrally Efficient Signalling for Wireless Optical Intensity Channels. PhD thesis, Dept. of Elec. & Comp. Engineering, University of Toronto, 2003. Online Resources & E-content(e-books, notes, ppts, video lectures etc.): NPTEL - https://onlinecourses.nptel.ac.in/noc21_mm26/preview				

	COURSERA - https://www.coursera.org/specializations/optical-engineering. Presidency University Library Link https://presiuniv.knimbus.com/user#/home ResearchPapers : 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 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. Guan-Lin Su, Pengfei Qiao, C. -Y. Lu, D. Bimberg and S. L. Chuang, "Low-threshold dielectric-cavity microlasers," 2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications, 2014, pp. 1-2.
	Topics relevant to “EMPLOYABILITY”: Fiber Optic Communication Systems for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Dr. Balaji K A
Recommended by the Board of Studies on		15th BOS held on28/07/2022
Date of Approval by the Academic Council		Meeting No. 18th, Dated 03/08/2022

Wearable Technologies Basket

Course Code: ECE3431	Course Title: Fundamentals of Wearable Sensing Type of Course: Program Core & Theory	L- T-P- C	3	0	0	3

Version No.		1.0
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 SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques using virtual testing through simulation in ANSYS software/Matlab/CCS Studio.
Course Outcomes		On successful completion of the course students shall be able to: Demonstrate the concept of resistive and reactive sensors which can be applied for real life applications. Understand the working principle of special purpose sensors and the need for developing smart sensors. Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals. Perform experimental study of various sensors.
Course Content:		

Module 1	Resistive and Reactive Sensors	Assignment		Case study based	08 Classes
	Topics: Overview of Measurement System, Instruments and errors in sensing systems. Resistive sensors- Potentiometers, strain gages (piezo-resistive effect), resistive temperature detectors (RTD), thermistors, magneto- resistors, light dependent resistor (LDR), resistive hygrometers, resistive gas sensors. Wearable applications: Strain sensor for monitoring Physiological signals, body movement.				
Module 2	Smart Sensors and Applications	Project		Small hardware based	09 Classes
	Topics: Integrated and Smart sensors, IEEE 1451 standard & Transducer Electronic Datasheets (TEDs), Overview of various smart sensors: Digital temperature sensor (DS1621, TMP36GZ), Humidity sensor (DHT11, DHT22, FC28), IR sensor (FC51), Gas sensor (MQ2,MQ8), Pressure sensors (BMP180), Accelerometers (ADXL335), etc, Structural health monitoring sensors, Introduction to MEMS and Flexible sensors.				
Module 3	Scope of Wearable Devices	Assignment		Small hardware based	08 Classes
	Topics: Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Wearable and noninvasive assistive technologies, Detection and Characterization of food intake by wearable sensors, Wearing sensors inside and outside of the Human body for early detection of diseases.				
	List of Laboratory Tasks: Nil				
	Targeted Application & Tools that can be used: Targeted Applications: : Fabrication of interdigitated (IDE) electrodes. Piezoresistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring. Smart textile for neurological rehabilitation system (NRS) Epidermal electronics system (EES) 3D imaging and motion capture safety and security, navigation, Enhancing sports media, Automatic digital diary				

	AI for respiratory diagnostics and clinical trials. Professionally Used Software: python/C,C++, Virtual testing through simulation in ANSYS software.
	Project work/Assignment/Quiz:
	1.Case Studies: At the end of the course students will be given a 'real-world' Wearable application based devices etc. as a case study. Students will be submitting a report which will include Block/Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
	Text Book(s): 1 "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, Academic Press/Elsevier, ISBN 978-0124186620, Edward Sazonov, Michael R. Neuman (editors), 2nd edition.
	Reference(s): Reference Book(s): 1 "Wearable Electronics Sensors-For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015 2 M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018. 3 "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018 Online Resources (e-books, notes, ppts, video lectures etc.): https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-

	wearable-technologies-FnyjT https://nptel.ac.in/courses/112/107/112107289/ https://nptel.ac.in/courses/112/105/112105249/ https://www.intechopen.com/chapters/66880 Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-Content: (Presidency University E-resources) https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications https://www.intechopen.com/books/5408 https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/ https://www.mdpi.com/books/pdfview/book/1088
	Topics related to development of "EMPLOYABILITY": Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, Health monitoring sensors. Students will learn various sensors and their broad applications from employability skills.

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

Course Code: ECE3433	Course Title: Wearable Devices and its Applications Type of Course: Discipline Elective &Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Fundamentals of Wireless Communication					
Anti-requisites	NIL					
Course Description	The objective of this course is to make the students to understand theneedfordevelopmentofwearable devicesanditsimplicationsonvarioussectors. It will also comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. The course will enable the students to become acquainted withvarious wearable locomotive sensors as assistive devices for tracking and navigation. This course also helps in carrying out research and development activities or employment opportunities in the area of wearable devices.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wearable Devices and its Applications and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					
Course Outcomes	On successful completion of the course students shall be able to: Identify and understand the need for development of wearable devices and their influence on various sectors. Discuss the applications of various wearable inertial sensors for biomedical applications. Identify the use of various wearable locomotivetools forsafety, security and navigation. Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistive devices.					
Course Content:						
Module 1	IntroductiontoWearableDevices	Quiz	Memory Recall based Quiz	09 Classes		

Topics:

Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview–sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

Module 2	WearableInertialSensors	Assignment	Case study based	08Classes

Topics:

Wearable Inertial Sensors-Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications:Fall Risk Assessment, Fall Detection, Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients.Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Altigraphs.

Module 3	WearableCamerasandMicrophonesforNavigation	Project	Small hardware based	14Classes

Topics:

Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sportsmedia, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: 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:

Fabricationofinterdigitated(IDE)electrodes.

Piezoresistive sensors for cuffless blood pressuremeasurement.

Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.

Smarttextileforneurologicalrehabilitationsystem(NRS)

Epidermalelectronicssystem(EES)

3Dimagingandmotioncapture

safety and security, navigation, Enhancing sportsmedia, Automatic digital diary

AIforrespiratorydiagnosticsand clinicaltrials.

Professionally Used Software: ANSYS software, python/C,C++

Project work/Assignment/Quiz:

Students will be made into groups and given programming assignments at the end of each module. Students need to use MULTISIM for these assignments.

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.

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,NripenChand a,AshokPandeyandAshisKumarSen,SpringerNatureSingaporePteLtd.

2018

4M.MardonovaandY.Choi,"ReviewofWearableDeviceTechnologyandIts

Applicationstothe MiningIndustry,"Energies, vol.11,p. 547,2018.

Online Lectures:

https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK

https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT

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)

https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w

https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/

https://www.mdpi.com/books/pdfview/book/1088

Topics relevant to “EMPLOYABILITY”: Design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications, Wearable devices with Global Positioning System (GPS) integration for tracking and navigation, Wearable Optical Sensors EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3434	Course Title:Embedded Platforms for Wearables Type of Course: Wearable Technologies, Theory only	L-T-P-C	3	0	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): Andrew N. Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide, Designing and Optimizing System Software”, Morgan Kaufmann Publishers, 1st edition Frank Vahid, Tony Givargis, “Embedded System Design: Unified Hardware/Software Design”, John Wiley & Sons,2ndEdition,
	Reference(s): Reference Book(s): Enzo Pasquale Scilingo, Gaetano Valenza, “Wearable Electronics and Embedded Computing Systems for Biomedical Applications”, MDPI AG, Switzerland, 1st Edition Alexander G. Dean, “Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach”, ARM Education Media, 2nd Edition ARM Cortex Datasheet available on (https://www.arm.com/) Online Resources (e-books, notes, ppts, video lectures etc.): Online NPTEL course :- https://onlinecourses.nptel.ac.in/noc22_ee12/preview Notes:https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/third-party/ddi0100e_arm_arm.pdf NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106105160/L22.html https://presiuniv.knimbus.com/user#/home E-content: 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 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#! 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 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: ECE3435	Course Title: Wireless Technologies for Wearables Type of Course: Discipline Elective & Theory only	L- T-P- C	3	0	0	3

Version No.		1.0
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:
	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. 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 . 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: “Seamless Healthcare Monitoring”, Toshiyo Tamura and Wenxi Chen, Springer 2018 “Wearable Sensors -Fundamentals, Implementation and Applications”, by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014. “Wearable and Autonomous Biomedical Devices and Systems for Smart Environment”, by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.
	Reference Books: “Wearable Electronics Sensors - For Safe and Healthy Living”, Subhas Chandra Mukhopadhyay, Springer 2015. “Environmental, Chemical and Medical Sensors”, by Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018 "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.): 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 >

	Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088> Case studies on Wearable technology<https://www.hticiitm.org/wearables> E-content: 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. Muhammad Mahtab Alam,"Wearable Wireless Sensor Networks: Applications, Standards and Research Trends"Jan 2015 http://dx.doi.org/10.1201/b20085-6. 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. 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: ECE3437	Course Title:Wearable and Ubiquitous Computing Type of Course: Discipline Elective, Theory Only	L-T-P-C	3	0	0	3

Version No.	1.0			
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): Jacob Rosan, "Wearable Robots", 2019, First Edition, Elsevier.				

https://nptel.ac.in/courses/106/103/106103220/ Online Resources (e-books, notes, ppts, video lectures etc.): Lecture Series on Embedded Systems by Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT Delhi (315) Lecture - 37 Pervasive & Ubiquitous Computing - YouTube 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: Context-awareness in wearable and ubiquitous computing by D Abowd, AK Dey, R Orr, J Brotherton - Virtual Reality, 1998 – Springer. An architecture concept for ubiquitous computing aware wearable computers by M Bauer, B Brugge, G Klinker, computing Systems ..., 2002 - ieeexplore.ieee.org 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: ECE3438	Course Title: Wearable Prosthetics and Robots Type of Course: Discipline Elective, IoT Basket Theory Only	L-T-P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of mechatronics and biomechanics					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the fundamentals of wearable robot which is a mechatronic system that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with. This course gives an overview of wearable robotics, providing the students with a complete understanding of the key applications and technologies suitable for its development. The 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:

Simulation of Stand-to-Sit Biomechanics for Robotic Exoskeletons and Prostheses with Energy Regeneration. IEEE Transactions on Medical Robotics

Benchmarking Wearable Robots: Challenges and ... – Frontiers-https://www.frontiersin.org › frobt.2020.561774 › full by D Torricelli · 2020

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

IoT & Sensor Technologies Basket

<table>
<tr><td>Course Code:

ECE3439</td><td colspan="3">Course Title: IoT: Architecture and Protocols

Type of Course:</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="8">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">The purpose of this course is to introduce the students to the 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="8">The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:

Discuss the various types of IoT architectures.

Explore various cloud based architecture.

Discuss various types of communication protocol used in IoT applications.

Design a IoT based application .</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>IoT Architecture & components</td><td colspan="3">Assignment/ Quiz</td><td colspan="2">Memory Recall based Quizzes</td><td>12 Sessions</td></tr>
<tr><td colspan="9">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</td></tr>
</table>

IoT standard Architecture, IoT world forum (IoTWF) standardized architecture. Architecture (2 ,3 Layer) , Physical device and control layer, Connectivity layer, edge computing layer, Upper layers, IoT reference Model . simplified IoT architecture-A core of IoT functional Stack				
Module 2	Data management	Assignment/ Quiz	Real time Application Project	12 Sessions
Topics: Selection of IoT Platform, Embedded System, data management and computing stack- Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud, AWS				
Module 3	Communication in IoT	Assignment/ Quiz	Memory Recall based Quiz	11 Sessions
Iot Accessing technology- IEEE 802.15.1, networking layers, physical layer and topology. IPV4 and IPV6 Addressing IoT nodes, IoT Edge, 6LOWPAN, MQTT, AMQP, COAP and MDNS, Web socket Application aware communication, Network and channel aware communication – Topologies and Hierarchy, IoT LAN and WAN connectivity RFID, BLE,LPWAN , LORA .Real time application of IoT.				
List of Laboratory Tasks: NIL				
Targeted Application & Tools that can be used: Important Applications range from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IOT Professionally Used Software: Kiel, C and Python, Arduino boards and RaspberiPi				
Project Work/Assignment: 1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format.Presidency University Library Link .				

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

4.Assignment:Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples.

Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate.

Assignment: 2] Design a IOT based application for

Health care

Agriculture

Transport Management

Stock Management

COVID-19

Text Book(s):

1. Sudip Misra, , Anandarup Mukherjee, Arijit Roy " Introduction to IOT ", Cambridge University Press, January 2021

Reference(s):

Reference Book(s):

R1 Arshdeep Bagha & Vijay Madisetti, " Internet of Things a Hands on Approach"

R2 Adrian McEwen & Hakim Cassimally "Designing the Internet of Things"

R3 IoT Fundamentals
Networking Technologies, Protocols, and Use Cases for the Internet of Things By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

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

1.. https://nptel.ac.in/courses/117/103/117103063/

2 .https://nptel.ac.in/courses/108108179

E-Content:-

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

Bertha Mazon-Olivo and Alberto Pan IEEE Latin America Transactions 1 Jan.-2022 Internet of Things: State-of-the-art, Computing Paradigms and Reference Architectures.

https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9662165

3. Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International

conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing

Architecture: A Critical Analysis.https://ieeexplore.ieee.org/document/8439638

Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International Conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.

https://ieeexplore.ieee.org/document/8439638

Topics relevant to the: “FOUNDATION SKILLS”, Introduction and background on IoT Technology, Introduction to IOT Technology, Cloud Computing

Topics relevant to the:” EMPLOYABILITY”, Industry 4.0 and IoT.

Catalogue prepared by	Mrs. Renuka Bhagwat
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 3/8/2022

Course Code: ECE3441	Course Title: IOT Edge Nodes and its Applications Type of Course : Theory	L-T- P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Concepts of Data Communication and Computer Networks, Embedded Systems.					
Anti-requisites	NIL					
Course Description	This course provides insights into the fundamentals of IOT and IOT based Edge nodes and systems to provide students with a good depth of knowledge of dsesigning Industrial IOT Systems for various applications. The course emphasizes on the IIOT architecture, Computing types, IOT Connecting technologies for IOT edge node.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of IOT Edge Nodes and its Applications and to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using open source Design Tools.					
Course Outcomes	On successful completion of this course the students shall be able to: Summarize the concept of IOT/IIOT and architecture of IoT/IIOT. Generalize the computing types and highlight its importance in edge computing. Demonstrate the computing types and highlight its importance in edge computing. Illustrate Legacy Industrial and Modern Communication Protocols and Middleware Architecture, LoRaWAN- and Augmented reality.					
Course Content:						
Module 1	Introduction to IoT	Assignment	Memory Recall based Quizzes	10 session		
Topics: Overview and Basic concepts of IoT, IoT architecture and components, - Sensors, Interface,						

<table>
<tr><td colspan="5">Networks, Key terms – IOT Platform, Interfaces, clouds, Data Analytics, Challenges. Various Architectures of IOT, Advantages & disadvantages. Physical Design of IoT, Logical Design of IoT, IoT enabling Technologies, IoT Applications.</td></tr>
<tr><td>Module 2</td><td>Introduction to IIOT and the technical and business Innovators of Industrial Internet</td><td>Assignment</td><td>Memory Recall</td><td>10 session</td></tr>
<tr><td colspan="5">Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT, Role of edge nodes in IoT. The Technical & Business Innovators of Industrial Internet: Miniaturization, Cyber Physical Systems, Wireless Technology, IP Mobility, NFV, Cloud and Fog, Big Data & Analytics, M2M & Artificial Intelligence, Augmented Reality, 3D Printing. IIOT Reference architecture.</td></tr>
<tr><td>Module 3</td><td>Introduction to Edge Computing and Challenges in Federating Edge Resources:</td><td>Assignment</td><td>Analysis and Verification</td><td>10 session</td></tr>
<tr><td colspan="5">Topics:

Edge Computing Fundamentals: Definition and importance of edge computing, Differences between edge and cloud computing, Advantages and challenges of edge computing. IoT Edge Node Components: Sensors and actuators, Microcontrollers and processors, Communication modules and protocols, Power management in edge nodes. Relevant Technologies of Edge Computing, Cloud-Hierarchy of Edge Computing-Business Models-Opportunities and Challenges in Federating Edge Resources, and Orchestration of Network Slices in 5G, Edge, and Clouds</td></tr>
<tr><td>Module 4</td><td>Protocols, Middleware Software Patterns and user case study for Industrial Internet Systems:</td><td>Quiz</td><td>Application</td><td>10 session</td></tr>
<tr><td colspan="5">Modern Communication Protocols-Proximity Network Communication Protocols- Wireless Communication Technologies- Gateways: industrial gateways - CoAP (Constrained Application Protocol)- NFC. Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS- Middleware Architecture- SigFox- LoRaWAN Augmented reality- Real-World Smart Factories, Application of IIOT: Case study: Health monitoring, IoT smart city, Smart irrigation, Robot surveillance.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
</table>

Course Code: ECE3442	Course Title: IoT and Cloud Computing Type of Course: Discipline Elective- IOT and Sensor Technologies Basket		L-T- P- C	3	0	0	3
Version No.	1.0						
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	14 sessions			

			tools	
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:

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

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

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: ECE3443	Course Title: Data Science for IOT Type of Course: Discipline Elective- IOT and Sensor Technologies Basket	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of Microprocessor programming and memory interfacing, knowledge of Python and Embedded C.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to support the students to understand the fundamentals of Data Science and Internet of Things (IOT) along with real time applications. The course will give awareness to students, about how two independent technologies depend on each other. This course explains students about how IOT would collect data from physical objects through different sensors, and how big data will allow the faster and more efficient storage and processing of data. This course will make students to understand the meaning of big data, which is to process a large amount of data on real time basis by using different storage technologies. This course will help the students who want to choose their career as Data Scientists or IOT Analyst and also encourage students to become entrepreneurs to launch new products in IOT and Data Science.					
Course objective	The objective of the course is to familiarize the learners with the concepts of Data Science for IOT and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to:					

	CO1: Explain the various concepts, terminologies and architecture of IOT systems. CO3: Recognize the role of big data, cloud computing and data analytics in a typical IOT system. CO3: Interface a node MCU to collect online data and carry out the computation.			
Course Content:				
Module 1	Fundamentals of IOT	Assignment/Quiz	IOT architectures, Frameworks and M2M	15Sessions
Introduction, Definitions & Characteristics of IOT, IOT Architectures, Physical & Logical Design of IOT, Enabling Technologies in IOT, History of IOT, About Things in IOT, The Identifiers in IOT, About the Internet in IOT, IOT frameworks, IOT and M2M				
Module 2	Data Handling& Analytics	Project	Data Analysis task	15Sessions
Introduction, Big data, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications				
Module 3	Applications of IOT	Assignment	IOT and Data Science. Real time applications	10Sessions
What is ESP8266 node-MCU Hardware Knowledge Hand Shake with ESP8266 Developing the Environment Overview about the board. Home Automation - Creating Webpage Button, Adding up required WEBPGE Elements Controlling Devices				
Targeted Application & Tools that can be used: Application Areas: Machine Learning, Deep Learning, Security Application, Home Automation, Wireless Communication in telecom industries. Professionally Used Software: Python, Embedded C, google cloud fire base				
Text Book(s): HakimaChaouchi, — “The Internet of Things Connecting Objects to the Web” ISBN: 978-1- 84821-140-7, Wiley Publications.Edition-1 Olivier Hersent, David Boswarthick, and Omar Elloumi, — “The Internet of Things: Key Applications and Protocols”, Wiley Publications. Edition-2				

References:

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 Du320, 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 Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: ECE3444	Course Title: Industrial Internet of Things (IIoT) Type of CourseDiscipline Elective- IOT Basket	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of Internet of Things					
Anti-requisites	NIL					
Course Description	The Industrial Internet of Things (IIoT) involves in the use of smart sensors and actuators to enhance manufacturing and industrial processes. This course concentrates on the transformation of industrial processes through integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. This course links the automation system with enterprise, planning and product lifecycle.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					

<table>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
Demonstrate the importance of Industrial IoT and its layers.
Illustrate the role of data analytics and machine learning in IIoT.
Ability to identify, formulate and solve problems by using Industrial IoT.
Make use of the concepts of IIoT in real applications.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction</td><td>Assignment</td><td></td><td>10 Sessions</td></tr>
<tr><td colspan="5">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>IIoT Layers</td><td>Assignment</td><td></td><td>9 Sessions</td></tr>
<tr><td colspan="5">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>IIoT Data Monitoring and Control</td><td>Assignment</td><td></td><td>10 Sessions</td></tr>
<tr><td colspan="5">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>Application Domains</td><td>Assignment</td><td>Case Study</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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="5">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
Schneider Electric
Hewlett Packard
Ericsson
Oil and Gas Refineries
Professionally Used Software:</td></tr>
</table>

Exosite ExoSense IoT

AWS IoT SiteWise

Text Book(s):

Sudip MIsra, Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press, First Edition, 2021

Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, First Edition 2021.

References

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

Waltenegus Dargie,Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice” , 1st Edition, Wiley Publications 2010

Dr. Ovidiu Vermesan, Dr. Peter Friess , “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems” , 1st Edition, River Publishers 2013.

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.):

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

NPTEL Course on "Introduction to internet of things, By Prof. Sudip Misra, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc20_cs66/preview

E-content:

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

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

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

Yao-Chung Chang, Ying-Hsun Lai, "Campus Edge Computing Network Based on IoT Street Lighting Nodes", IEEE Systems Journal, Volume: 14, Issue: 1, March 2020, pp:164 - 171, https://ieeexplore.ieee.org/document/8490873

Topics related to development of “SKILL DEVELOPMENT”: IIoT Sensing, IIoT Processing, IIoT Communication. Topics related to development of “EMPLOYABILITY”: Plant Safety and Security (Including AR and VR safety applications), Facility Management.	
Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Srilakshmi K H
Recommended by the Board of Studies on	BOS NO: 15 th BOS held on 28/7/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3445	Course Title: Internet of Medical Things Type of Course: Program Core IoT Basket Theory	L- T-P-C	3	0	0	3
Version No.	1.0					
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: Summarize the architectures of IoMT Devices and their system applications. Apply the IoMT Schema for Remote Patient Monitoring. Examine the operation of Block chain Technology for Privacy-Protection of Medical health records. Analyze the data compression methods for lossless Medical Data Transmission.			
Course Objective	The objective of the course is to familiarize the learners with the concepts of Internet of Medical Things (IoMT) and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques			
Course Content:				
Module 1	Introduction to IoMT	Quiz	Threats and Challenges of IoMT	12 Sessions
Topics: Introduction to IoMT, IoMT Devices: On-Body Devices, In-Home Devices, Community Devices, In-Clinic Devices, In-Hospital Devices, IoMT System Architecture: Data Collection Layer, Data Management Layer, Medical Server Layer, IoMT Attack Types, Challenges in IoMT Security Schemes.				
Module 2	Healthcare Schema using IoMT for Remote Patient Monitoring	Assignment	Solution for Storage and Transfer of Medical Data in IoTM	10 Sessions
Topics: Intelligent Transit Healthcare Schema Using IoMT Networking System: Vibration-Sensing Methodology for Accident Detection, System Safeguards, GPS Integration, Hospital Communication About Accident Location, MCU Connection with the ITH-IoMT Subsystem, GPS-Enabled Module for Location Information, ECG and Health Data Monitoring Schema.				
Module 3	Privacy Protection of IoMT-Based Health Records using Blockchain Technology	Assignment	GPS and GUI based medical data storage in EHR	8 Sessions
Topics: Introduction to Blockchain, Applications of Blockchain, Blockchain Advantages and Challenges, Personal Health Data Collection, Virtual Private Server (VPS)-Based Hyperledger Fabric Framework, Remote Monitoring Software Development				

Module 4	Medical Data Compression for Lossless Data Transmission	Assignment	Compression methods for telemedicine applications	8 Sessions

Topics: Introduction to Medical Data Compression: Lossless Compression , Lossy Compression, Significance of Medical Data Compression, Benefits of Medical Data Compression, Characteristics of Data Acquisition and Storage, Data Compression Techniques for Lossless Data Transmission: Coding Scheme, Bandwidth, Storage and Data Compression Techniques.

Targeted Application & Tools that can be used:

Application: It includes complete Healthcare Automation Setup in Medical field with an objective to make health facilities accessible to everyone irrespective of geographical location.

Professionally Used Software: ITM-IoMT System, GPS-GUI System, GPS-Framework uses Global Navigation Satellite System-(GNSS),GPS-gadgets to provide data on location, vehicle speed, time and direction.

QUIZ/Assignment:

1. Project/Programming Assignment: Students will be made into group and given the programming assignment at the end of each module. Students need to use GPS-GUI for this assignments.

Sample Assignment 1: Study of wearable smart devices for remote healthcare monitoring to detect cardiac diseases.

Sample Assignment 2: Smart assistance of elderly individuals in emergency situations at home.

2. Book Review/ Article review: A chapter of a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. Presidency University Library Link:- https://presiuniv.knimbus.com/user#/home

Presidency University Library Link .

3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.

Text Book(s):

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)

Krishna Singh, Mohammed Elhoseny, Akansha Singh, Ahmed Elngar, “Machine Learning and the

Internet of Medical Things in Healthcare", 1st Edition-2021, Elsevier Publication.

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

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

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.

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

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:

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

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

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.

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

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

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

Artificial Intelligence Basket

Course Code: ECE3447	Course Title: Computational Intelligence and Machine Learning Type of Course: Discipline Elective- General	L- T-P- C	3	0	0	3

	Basket					
Version No.	2.0					
Course Pre-requisites	Basic concepts of matrix operations, probability theory, vector and array representation.					
Anti-requisites	NIL					
Course Description	The course aims to make the students to understand the mathematical approaches for machine learning and computational intelligence algorithms. This course covers the basic concepts of Neural Networks which will enable the students to understand the concepts of machine learning. Concepts of Linear models for regression and classification will be discussed in such way that students can able to perform data analysis in practical applications. In this course, Computational intelligence algorithms are included to get better understanding of Artificial intelligence.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Computational Intelligence and Machine Learning and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.					
Course Outcomes	On successful completion of the course the students shall be able to: Analyze and fundamental concepts of neural networks Implement ML algorithms to regression, classification, clustering, and dimensionality reduction Categorize the various pattern recognition techniques using machine learning into supervised and unsupervised.					
Course Content:						
Module 1	Fundamentals of ANN	Assignment	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	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	14 Sessions
Topics: Kernel methods: Dual representations-Constructing kernels, K- means Algorithm, Fuzzy K- means Algorithm, Kohonen Self organizing Maps, Maximum margin classifier (Support Vector Machine), Particle swarm optimization--Ant colony optimization- Bacterial foraging. Genetic algorithm.				
List of Laboratory Tasks: Nil				
Targeted Application & Tools that can be used: Targeted Applications: This course is contributed for placement in data science companies, research & development work and also useful to know the existing & developing Artificial Intelligence. Professionally Used Software: MatLab, Phython				
Text Books: 1. Pattern recognition and machine learning, Christopher M. Bishop, TMH, Springer, 2010 2. Algorithm Collections for Digital Signal Processing Applications Using Matlab, E.S. Gopi, Springer.				
Reference(s): Reference Books 1. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020. Online Resources (e-books, notes, ppts, video lectures etc.): 1. https://youtube.com/playlist?list=PL1xHD4vteKYVpaliy295pg6_SY5qznc77 2. https://archive.ics.uci.edu/ml/index.php 3.https://presiuniv.knimbus.com/user#/home E-content: 1. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu, Lin Ye, A review of the application of machine learning in water quality evaluation, Eco-Environment & Health, 2022, ISSN 2772-9850, https://doi.org/10.1016/j.eehl.2022.06.001. 2. Lin Li, Yici Cai, Qiang Zhou, A survey on machine learning-based routing for VLSI physical design,				

Integration, Volume 86, 2022, Pages 51-56, ISSN 0167-9260,

https://doi.org/10.1016/j.vlsi.2022.05.003.

3. Vijaya B. Kolachalama, Machine learning and pre-medical education, Artificial Intelligence in Medicine,

Volume 129, 2022, 102313, ISSN 0933-3657,

https://doi.org/10.1016/j.artmed.2022.102313.

4. Sergio Ledesma, Mario-Alberto Ibarra-Manzano, Dora-Luz Almanza-Ojeda, Juan Gabriel Avina-Cervantes, Eduardo Cabal-Yepez, On removing conflicts for machine learning, Expert Systems with Applications,

Volume 206, 2022, 117835, ISSN 0957-4174,

https://doi.org/10.1016/j.eswa.2022.117835

Topics relevant to "EMPLOYABILITY SKILLS": Artificial Neural Networks, Learning Algorithms, linear regression for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. G Tirumala Vasu
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 16th , Dated 23/10/2021

Version No.	1.0		
Course Pre-requisites	NA		
Anti-requisites	NIL		
Course Description	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.		
Course Objective	The objective of the course is to familiarize the learners with the concepts of Neural Networks and Deep Learning and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING.		
Course Outcomes	On successful completion of this course the students shall be able to: Summarize the basics of Neural networks. Illustrate the Convolutional Neural Network Demonstrate the basic concepts of deep learning		
Course Content:			
Module 1	Introduction To Neural Networks	Quiz and assignments	10 SESSION
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			
Module 2	Convolutional Neural Network	assignments	10 SESSION
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-			
Module 3	Deep Learning	Quiz and assignments	10 SESSION
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.			
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

Text Book(s):

Simon S. Haykin, Neural Networks and Learning Machines, 3rd Ed, Pearson, 2009.

Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing NextGeneration Machine Intelligence Algorithms", O'ReillyMedia, 2017.

References:

Reference Book

José C. Principe, Neil R. Euliano, W. Curt Lefebvre, Neural and Adaptive Systems: Fundamentals through Simulations, John Wiley and Sons, 2000.

Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

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:

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

Qin Zou , Member, IEEE, Lihao Ni , Tong Zhang , and Qian Wang, "Deep Learning Based Feature Selection for

<table>
<tr><td colspan="2">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

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

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</td></tr>
<tr><td colspan="2">Topics relevant to "EMPLOYABILITY SKILLS": Deep Learning, Neural network, Reinforcement Learning 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 G MUTHUPANDI

Mrs ANUPAMA SINDGI</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>12th BOS held on 10/08/2021</td></tr>
<tr><td>Date of Approval by the Academic Council</td><td>Meeting No. 16th , Dated 23/10/2021</td></tr>
</table>

Course Code: ECE3451	Course Title: AI & Digital Health Type of Course: Discipline Elective- AI Basket		L-T-P-C	3	0	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: Explain basic principles of AI & Digital Health. Understand the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning. Illustrate object-oriented concepts. 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:

https://www.coursera.org/learn/introduction-to-digital-health

https://ocw.mit.edu/courses/health-sciences-and-technology/hst-947-medical-artificial-intelligence-spring-2005/

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

Yu, Kun-Hsing, Andrew L. Beam, and Isaac S. Kohane. "Artificial intelligence in healthcare." Nature biomedical engineering 2, no. 10 (2018): 719-731.

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.

Ghazal, Taher M. "Internet of things with artificial intelligence for health care security." Arabian Journal for Science and Engineering, Springer nature (2021): 1-12.

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: ECE3452	Course Title: Natural Language Processing Type of Course: Open Elective Theory only		L- T-P- C	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Prior exposure to discrete math, probability, linear algebra, optimization, linguistics, artificial intelligence, machine learning and familiarity with python will be useful but not required						
Anti-requisites	NIL						
Course Description	This course is intended as a theoretical and methodological introduction to the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language through programming and simulation.						
Course Objective	This course is designed to develop Entrepreneurial skills by using Experiential Learning Techniques						
Course Outcomes	On successful completion of this course the students shall be able to: (1) Understand basics in natural language processing methods and strategies. (2) Evaluate the strengths and weaknesses of various NLP technologies and frameworks (3) Employ literary-historical NLP-based analytic techniques like stylometry, topic modeling, synsets and named entity recognition.						
Course Content:							
Module 1	Syntactic Processing	Assignment	Programming and Simulation task	09 Sessions			
Topics: Introduction, Linguistic Background, Grammars and Parsing, Features and Augmented Grammars, Grammars for Natural Language, Toward Efficient Parsing, Ambiguity Resolution: Statistical Methods							
Module 2	Semantic Interpretation	Assignment	Programming and Simulation task	11 Sessions			
Topics:							

Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity Resolution, Other Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases.				
Module 3	Context and World Knowledge	Assignment	Programming and Simulation task	10 Sessions
Topics: Knowledge Representation and Reasoning, Local Discourse Context and Reference, Using World Knowledge, Discourse Structure, Defining a Conversational Agent				
Module 4	INFORMATION RETRIEVAL AND LEXICAL RESOURCES:	Assignment	Programming 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: MonkeyLearn AYLIEN Spark NLP IBM Watson KILT				
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 Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.				

<table>
<tr><td colspan="2">Manning, Christopher and Heinrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python– Analyzing Text with the Natural Language Toolkit (O'Reilly 2009, website 2018)

Dipanjan Sarkar, Text Analytics with Python (Apress/Springer, 2016)

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

Natural Language Tool Kit

Stanford University CS224n: Natural Language Processing with Deep Learning

Paul Vierthaler's Stylometric PCA and Network Data Explorer

NLP 100 Exercise 2020 (Rev 2) - NLP100 2020

Natural Language Processing and Machine Learning (princeton.edu)

E-content:

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.

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

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

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/9332458Other Resources:

Presidency University Library Link https://presiuniv.knimbus.com/user#/home</td></tr>
<tr><td colspan="2">Topics relevant to development of "FOUNDATION SKILLS":</td></tr>
<tr><td>Catalogue prepared by</td><td>Dr. Rajiv Ranjan Singh

Mr. Ramzan Basheer

Ashwini B</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td>BOS Meeting NO: 15th BOS held on 28/07/2022</td></tr>
</table>

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

Open Eletives

Course Code: ECE3801	Course Title: Microprocessor based Systems Type of Course: Open Elective &Theory Only	L-T-P-C	3	0	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.):

The Intel Microprocessors: Architecture Programming and Interfacing book by Barry B. Brey, Eighth Edition <https://userpages.umbc.edu/~squire/intel_book.pdf>

Microprocessors Lectures adapted from slides and the textbook materials of Dr. Kip Irvine <https://www.philadelphia.edu.jo/academics/qhamarsheh/page.php?id=13>

Documentation for Emu8086
<https://www.philadelphia.edu.jo/academics/qhamarsheh/uploads/emu8086.pdf>

Microprocessors and Interfacing NPTEL Video Lectures
<https://nptel.ac.in/courses/108/103/108103157/>

x86 Assembly Language Programming <https://cs.lmu.edu/~ray/notes/x86assembly/>

E-content:

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

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

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

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

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: ECE3802	Course Title: Artificial Neural Networks Type of Course: Open Elective Theory	L- T-P- C	3	0	0	3
Version No.	1.0					
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: Distinguish Learning paradigms and Learning Algorithms for a simple neural network. Explain the implementation of linearly separable/ Non- linearly separable problems with SLP/ MLP. Illustrate the implementation of non-linearly separable problems with MLP. 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 – 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. Implement the perceptron model of a two-input XOR gate in MATLAB/ Python and verify the structure using the truth table. 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) 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): Simon Haykin, "Neural Networks and Learning Machines", Pearson. Reference Book(s) C. Bishop, “Neural Networks for Pattern Recognition”, Oxford University Press. K. Mehrotra, C. Mohan, and S. Ranka, “Elements of Artificial Neural Networks”, MIT Press 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.): Introduction to ANN (NPTEL) - https://nptel.ac.in/courses/117/105/117105084/ Artificial Intelligence Courses (Udemy) - https://www.udemy.com/topic/artificial-intelligence/ Supervised Machine Learning: Regression and Classification by Dr. Andrew Ng (Coursera) - https://www.coursera.org/learn/machine-learning E-content: 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

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

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

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: ECE3803	Course Title: Smart Electronics in Agriculture Type of Course:	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts assembly programming and embedded C, Understanding of interfacing Memory and peripherals.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce students to smart and precision based agriculture 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	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.			
Course Outcomes	On successful completion of this course the students shall be able to: (1) Explain the Components and Process of Agriculture. (2) Demonstrate the electronics smart sensors and embedded systems. (3) Employ techniques for cloud based application in agriculture.			
Course Content:				
Module 1	Component of Agriculture	QUIZ	Comprehension level Quiz	12 classes
Topics: Indian Agriculture and green revolution. Methods of agriculture and role of technology in agriculture. Role of technology in fertilizers and pesticide and irrigation management in modern agriculture, integrating big data Practices in Agriculture, Internet of things (IoT) and data analytics in smart agriculture: Functional framework for IoT-based agricultural system Functional framework for edge-based agricultural system Benefits and challenges. IoT fundamentals and its applications devices for smart agriculture. Precision agriculture Hydroponics.				
Module 2	Smart electronic for Agriculture	Case Study	Sensor and Embedded system	15 classes
Topics: Sensors and actuator for agriculture, smart embedded systems, understanding Arduino Boards, Programming and Interfacing. Selection of Embedded Platform. IoT technology Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud. Iot Accessing technology- IEEE 802.15.1,IPV4 and IPV6 Addressing IoT nodes, IoT Edge, MQTT, AMQP, COAP Interfacing RFID and Sensors and Actuators through Protocols				
Module 3	Cloud Based IoT Applications	Mini Project	System Design Task and Analysis	12 Classes
Topics: The Internet of Things in agriculture for sustainable rural development. Internet of Things (IoT) in agriculture toward urban greening. Smart e-agriculture monitoring systems , smart agriculture using renewable energy and AI-powered IoT. Surveying smart farming for smart cities, Farm Automation. A fog computing-based IoT framework for				

prediction of crop disease using big data analytics
Agribots: A gateway to the next revolution in agriculture, Transforming IoT in aquaculture: A cloud solution

Targeted Application & Tools that can be used:

Important Applications range from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IOT

Professionally Used Software: Kiel, C and Python

Project work/Assignment:

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

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

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

4.Assignment:Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples.

Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate.

Assignment: 2] Design a IOT based application for

Climate condition monitoring and automated systems

Internet of Things on sustainable aquaculture system

IoT-based monitoring system for freshwater fish farming: Analysis and design

Design a IoT based agricultural system for optimal management

Textbook(s):

1. Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu Kumar Pani "AI, Edge and IoT-based Smart Agriculture "1st Edition November 10, 2021

2. Prasant Kumar Pattnaik, Raghvendra Kumar, S. N. Panda, Souvik Pal " IoT and Analytics for Agriculture"2020

References

1.. Arshdeep Bagha & Vijay Madisetti, " Internet of Things a Hands on Approach"

2. Adrian McEwen & Hakim Cassimally "Designing the Internet of Things".

3.IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

E-Content:-

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

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

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

Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International Conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.

https://ieeexplore.ieee.org/document/8439638

5 Introduction To Internet Of Things - Course (nptel.ac.in)

Topics relevant to development of "Emplobility": The Internet of Things in agriculture for sustainable rural development.
Internet of Things (IoT) in agriculture toward urban greening. Topics relevant to development of "Entrepreneurship" : Smart e-agriculture monitoring systems , AI-powered IoT. Surveying smart farming for smart cities, Farm Automation.

Catalogue prepared by	Ms.Renuka Bhagwat
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022

Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 3/8/2022

Course Code: ECE3804	Course Title: Environment Monitoring system Type of Course: Open Elective	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	Internet of Things					
Course Description	This course provides fundamental concepts of various environment monitoring eco systems. It provide students with deep knowledge of sensors and data acquisition systems to monitor atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems. The course also provides students with deep knowledge of importance of single board computers and data loggers.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					

<table>
<tr><td>Course Outcomes</td><td colspan="4">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.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>From Sensors to systems.</td><td>Assignment / Quiz</td><td>Memory Interfacing Task and Analysis</td><td>12 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>Data Acquisition systems</td><td>Assignment</td><td>Memory Interfacing Task and Analysis</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Applications</td><td>Assignment</td><td>Programming and Simulation task.</td><td>09 Sessions</td></tr>
<tr><td colspan="5">Topics: Atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:</td></tr>
</table>

Application Area:

Environmental monitoring applications are essential to generating information about the quality of the environment around us, including whether it is improving, worsening, or staying the same. The kind of data environmental monitoring applications produce assist in decision making, both by governments and private actors. Of course policymakers need accurate, reliable information from applied environmental monitoring, and so do municipal engineers, public health experts, first responders dealing with environmental emergencies, farmers, foresters, hunters, and recreational wilderness users all rely upon these applications.

Professionally Used Software: students can use open SOURCE Softwares like Keil, Python IDLE etc.

Project work/Assignment:

1. Mini Projects: At the end of the course students will be assigned a project work on solving many environmental monitoring issues in real time.

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

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

Textbook(s):

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.):

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 >

Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088 Case studies on Wearable technology< https://www.hticiitm.org/wearables> E-content: Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ISBN-13: 978-1882417087. 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. 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. F. Sánchez-Rosario et al., "A low consumption real time environmental monitoring system for smart cities based on ZigBee wireless sensor network," 2015, pp. 702-707, doi: 10.1109/IWCMC.2015.7289169. https://ieeexplore.ieee.org/document/7289169.
Topics relevant to development of "SKILL": System design for environmental monitoring systems.

Catalogue prepared by	Dr. Divya Rani
Recommended by the Board of Studies on	BOS 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: ECE3805	Course Title: Consumer Electronics Type of Course: Open Elective	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basics of Electronics					
Anti-requisites	NIL					

Course Description	This course is designed to enhance the knowledge, skills and attitude in performing testing assembling/disassembling of electronic components, maintaining and repairing audio/video products and systems, terminating/connecting electrical & electronics circuit and maintaining and repairing electrically-controlled domestic appliance .It also covers Computer operation with internet browsing, industry control system, Color TV, LCD, LED,CD VCD, DVD, IPS, UPS, cellular phone, House hold appliance and using specialized equipment repair and commissioning of consumer electronic products and systems.			
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques			
Course Outcomes	On successful completion of this course the students shall be able to: Identify the devices and system functions Classify the components in electronics Demonstrate and explain the house hold appliances			
Course Content:				
Module 1	Audio Fundamentals, Devices & Systems	Assignment/ Quiz	Memory Recall based Quizzes	15 Sessions
Topics: Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types. Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types.				
Module 2	Television Fundamentals	Assignment/ Quiz	Real time Application Project	15 Sessions
Topics: Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution, Composite video signal, Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance, Different types of TV camera, Transmission standards. PAL-D colour TV receiver, Digital TVs:- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver, Video interface, Digital Video, SDI, HDMI Multimedia Interface , Digital Video Interface, CD and DVD player.				
Module 3	Home / Office Appliances	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions
Home Appliances: Inverter, Microwave oven, Domestic Refrigerator, Controls in Refrigerator, Room Air Conditioning.				

Office Appliances : Calculator, Facsimile (FAX) and Pager.

Targeted Application & Tools that can be used:

Consumer Electronics appear in a variety of application in repairing the electrical, electronic components and devices, repair of consumer house hold appliances

Professionally Used Software: Multisim

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based on consumer electronics. Students will be submitting a report on the same which will include in appropriate format.

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

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

4. Project Assignments:

Consumer electronic products are invariably covered by a 'Manufacturer's Warranty' which offers the purchaser some protection against detective workmanship and component failure during a limited term.

Assignment 1: Device control using Smart Phone's Bluetooth

Assignment 2: Stereophonic Acoustic Echo Suppression for Speech Interfaces for Intelligent TV Applications.

Text Book(s):

1. Bali.S.P, "Consumer Electronics", Pearson Education India,2010 , latest edition

Reference(s):

Reference Book(s):

R1 Bali R and Bali S.P, "Audio video systems : principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd., 2010Delhi , India, latest edition

R2 Gulati R.R., "Modern Television practices", New Age International Publication (P) Ltd. New Delhi Year 2011, latest edition.

R3 Gupta R.G. "Audio video systems", Tata Mc graw Hill, New Delhi, India 2010, latest editio

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

1. https://nptel.ac.in/courses/117108140

2. https://en.wikipedia.org/wiki/Consumer_electronics

E-content:

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.

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

F. Pieri, C. Zambelli, A. Nannini, P. Olivo and S. Saponara, "Is Consumer Electronics Redesigning Our Cars?: Challenges of Integrated Technologies for Sensing, Computing, and Storage," in IEEE Consumer Electronics Magazine, vol. 7, no. 5, pp. 8-17, Sept. 2018, doi: 10.1109/MCE.2017.2771515.

Topics relevant to the: “FOUNDATION SKILLS”, Television fundamentals with their applications.

Topics relevant to the:” EMPLOYABILITY”, Home / Office Appliances .

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

Course Code: ECE3806	Course Title: Product Design of Electronic Equipment Type of Course: Open Elective Theory only	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-	NIL					

requisites				
Anti-requisites	NIL			
Course Description	The purpose of this course is to give the students the opportunity to improve their design abilities for some well-known consumer electrical goods. Basic circuit configurations for many different electronic goods are covered throughout the course. By taking into account their electrical, mechanical, ergonomic, and aesthetic design aspects, the students will be able to design and develop various electronic components. The course's thoroughness includes a variety of tests, computer-aided design-based tools, and mockup-based projects that help students develop their talents to work independently as product design engineers.			
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING technique for designing various electronic products			
Course Outcomes	On successful completion of this course the students shall be able to: (1) Outline various electronic products and their design considerations. (2) Discuss PCB design and fabrication flow.. (3) Report ergonomic, aesthetic and packaging requirements of electronic products. (4) Discover safety and reliability issues and compliance requirement in electronic products design.			
Course Content:				
Module 1	Overview of Electronic Products and Product Design Considerations	Quiz	Memory Recall based Quizzes	10 Classes
Topics: Audio Systems; Video Systems and; Domestic & Consumer; Air-conditioners and Refrigerators; Computers office Systems; Telephone & Mobile Radio Systems.				
Module 2	PCB Design and Manufacturing	Assignment / Quiz	Programming and Simulation task	12 Classes
Topics: Power Supply Design – Basic circuit configurations, Regulators, Switching Regulators, Switch Mode Power Supply, PWM Control methods; CAD Tools for PCB Design – Design Rules, Schematic, Simulation, Netlist Import, Place and Route, Advance PCBs; PCB Fabrication				

Process; Electromagnetic Interference (EMI) – EMC and EMI, EMI Reduction and Shielding.				
Module 3	Ergonomics and Packaging for Electronic Products	Assignment	Mock up Design and Analysis Tasks	10 Classes
Topics: Ergonomics and Aesthetics in Electronic Product Design – Overview of Ergonomics and Aesthetics in for Electronic Products, issues in placement and integration various electronic components; Packaging, Enclosures and Cooling of Electronic Systems; 3D Printing and Computer Aided Design.				
Module 4	Product Safety and 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				
Project work/Assignment:				
1. Case Studies: At the end of the course students will be given a 'real-world' product design design case studies. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. and/or a mock-up model in appropriate format. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. <https://presiuniv.knimbus.com/user#/home >. 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. Project Assignment: Carry out various design and analysis task for various consumer electronics products. Assignment: 1] Simulate and design the layout of an audio amplifier PCB..				

Assignment 2: Prepare a mockup model of an electronic product by considering ergonomic and aesthetic issues in mind (e.g. a new mouse, a new table lamp, an audio device etc.)

Textbook(s):

Bali, S. P. Consumer Electronics. Pearson Education India, 2007.

Mitzner, Kraig. Complete PCB design using OrCad capture and layout. Elsevier, 2011.

Reference(s):

Reference Book(s):

Mitzner, Kraig. Complete PCB design using OrCad capture and layout. Elsevier, 2011.

Reis, Ronald A. "Electronic project design and fabrication." (1989).

Bagad, V. S. Electronics Product Design. Technical Publications, 2009.

Ohring, Milton, and Lucian Kasprzak. Reliability and failure of electronic materials and devices. Academic Press, 2014.

O'Connor, Patrick, and Andre Kleyner. Practical reliability engineering. John Wiley & Sons, 2012.

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

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

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

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

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:

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

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

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

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

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

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

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 “EMPLOYABILITY”: Working Principles of various electronic consumer products, PCB Design.

Topics relevant to development of “ENVIRONMENT AND SUSTAINABILITY SKILLS”: Types of materials and wastes produced during fabrication processes as well as discarded electronic waste.

Catalogue prepared by	Dr. Rajiv Ranjan Singh
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code: ECE3807</td><td>Course Title: Introduction to Data Analytics
Type of Course: Open Elective
Theory</td><td>L- T- P- C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">Probability and Statistics</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">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.</td></tr>
<tr><td>Course Objective</td><td colspan="6">This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1 Describe fundamental concepts of data analysis processes

CO2 Compare various techniques for data handling using python

CO3 Analyze transformation and visualization techniques in structures and time-series datasets

CO4 Make use of statistical techniques to handle data

CO5 Examine supervised machine learning models using scikit-learn

CO6 Design a complete data analytics solution using Python</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td>Module 1</td><td>Introduction to Data Analytics</td><td colspan="2">Quiz/Assignment</td><td colspan="2">Memory Recall based Quizzes/Assignments</td><td>6 classes</td></tr>
<tr><td colspan="7">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</td></tr>
</table>

or Text Files, Time Series data analysis				
Module 2	Introduction to the Python's World- Plotting and Visualization	Quiz/Assignment	Programming, Analysis and Visualization	8 classes
Topics: Python—The Programming Language, Python 2 and Python 3, IPython, and Jupyter Notebooks, Essential Python Libraries, NumPy, pandas, matplotlib, SciPy, scikit-learn, Built-in Data Structures, Functions, and Files, The matplotlib Library, Plotting with pandas and seaborn, Other Python Visualization Tools.				
Module 3	Statistics, data, and Statistical Thinking	Assignment	Programming, Analysis and Visualization	8 classes
Topics: Describing Qualitative Data, Numerical Measures of Central Tendency, using the Mean and Standard Deviation to Describe Data, Methods for Detecting Outliers: Box Plots and z-Scores, Types of Random Variables, Probability Distributions for Discrete Random Variables, Expected Values of Discrete Random Variables, The Binomial Random Variable, The Poisson Random Variable, Statistical inference, Bias, The method of moments, Least squares/weighted least squares, Maximum likelihood				
Module 4	Machine Learning with scikit-learn	Assignment	Programming, Analysis and Visualization	9 classes
Topics: The scikit-learn Library, Supervised Learning with scikit-learn, The Iris Flower Dataset, K-Nearest Neighbors Classifier, Linear Regression, The Least Square Regression, Support Vector Machines (SVMs)				
Project work/Assignment:				
1. Project: At the end of the course, students will be given a 'real-world' data analytics application based topic as a project. Students will be submitting a report, which will include different steps of data cleaning and preparation, plotting and visualization and Results of the analysis etc. in appropriate format. 2. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. 3. Assignments:				

Assignment 1: Using Python programming, the students are required to analyze loan application data.

Assignment 2: Using Python programming, the students are required to analyze stock price data and perform different steps of data cleaning and preparation, plotting and visualization

Textbook

T1. Wes McKinney, "Python for Data Analysis: Data Wrangling With Pandas, Numpy, And Ipython", O'Reilly Publications, 2017

T2. Fabio Nelli, "Python Data Analytics Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language", Apress.

References

R1. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.

R2. Leonard Kaufman, Peter J. Rousseeuw (1990). Finding Groups in Data: An Introduction to Cluster Analysis. "John Wiley & Sons, Inc".

Topics for Technology Enabled Learning:

1. Data Analysis with Python | Coursera, Offered by IBM

https://www.coursera.org/professional-certificates/ibm-data-analyst

2. Data Analytics with Python - NPTEL Online Courses, by Prof. A Ramesh | IIT Roorkee

https://onlinecourses.nptel.ac.in/noc21_cs45/preview

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 "HUMAN VALUES &PROFESSIONAL ETHICS": Concepts of Data collection and analysis for an assignment.

Catalogue prepared by	Mrs. Pallabi Kakati
Recommended by the Board of Studies on	BOS Meeting NO: 15th, Dated BOS 28/07/2022

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

Course Code: ECE3808	Course Title : Machine Vision for Robotics Type of Course: Theory	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NA					
Anti-requisites	NIL					
Course Description	The purpose of this course is to teach the principles and applications of vision system in modern manufacturing Environment. The nature of this course is analytical with practical understanding. It is also intended at introducing basic concepts to Non ECE and CSE students. The course is analytical in nature and needs fair knowledge of digital image processing. The first part of the course focuses the basics vision systems and object recognition. Further, it explores the knowledge in robot vision applications.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: Explore various vision systems for Machines Understand the image capturing and processing techniques Apply the robotic operating system to Machines					
Course Content:						
Module 1	Overview of Machine Vision in IP	Quizzes and assignments	12 SESSION			
Topics: Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interface- Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction- Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values.						

Module 2	Vision algorithms and applications	Quizzes and assignments	12 SESSION
Topics: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.			
Module 3	ROBOT Vision	Quizzes and assignments	12 SESSION
Topics: Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package			
Targeted Application & Tools that can be used: Application Area includes all intelligence devices like Unmanned Vehicle. The students will be able to join a profession which involves basics to high level of automation design and analysis. Professionally Used Software: PYTHON, MATLAB, JAVA. PyTorch, AWS cloud, Torch, Keras, TensorFlow-IBM Watson			
Project work/Assignment: 1.Case Studies: At the end of the course students will be given a real-world scenario for any application like, Drive the solution of a shape-from-shading problem at a singular point, by fitting a smooth local shape near the singular point. Students will be submitting a report which will include Design and implementation methodology. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. 4.Assignment 1:) Consider a flying robotic system that uses binocular stereo to obtain three dimensional information from pairs of images. Suppose that the scale of the recovered three dimensional coordinates is not known accurately because the baseline between exposure stations is not known with precision. Now suppose that two such three-dimensional models — obtained along different flight paths — are to be related. In this case, determining the absolute orientation requires that, in addition to translation and rotation, a scale factor relating the two three dimensional models be found as well.			

Text Book(s):

Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, WILEY-VCH, Weinheim,2008.

Damian m Lyons, “Cluster Computing for Robotics and Computer Vision”, World Scientific, Singapore, 2011.

References:
Reference Book
Rafael C. Gonzalez and Richard E.woods, “Digital Image Processing”, Addition - Wesley Publishing Company, New Delhi, 2007.
Shimon Ullman, “High-Level Vision: Object recognition and Visual Cognition”, A Bradford Book, USA, 2000.
3. R.Patrick Goebel, “ ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I”, A Pi Robot Production, 2012.
K. Mehrotra, C. Mohan, and S. Ranka, “Elements of Artificial Neural Networks”, MIT Press
Online Resources (e-books, notes, ppts, video lectures etc.):
6.801 / 6.868 Machine Vision, Lecture 2 (mit.edu)
6.801/6.866: Machine Vision, Lecture 8 (mit.edu)
6.801/6.866: Machine Vision, Lecture 11 (mit.edu)
6.801/6.866: Machine Vision, Lecture 13 (mit.edu)
6.801/6.866: Machine Vision, Lecture 23 (mit.edu)
NPTEL - Robotics - Course (nptel.ac.in)
Python Machine Learning Tutorial (Data Science) - Bing video
E-Book 1.Machine Vision (November 1996 edition) | Open Library
https://presiuniv.knimbus.com/user#/home
E-Content
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
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
Markus Ulrich, Christian Wiedemann, Carsten Steger: “ CAD-Based Recognition of 3D Objects in Monocular Images” International Conference on Robotics and Automation (2009).
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 on 28/07/2022
Date of Approval by the 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-T- P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	[1] IoT Robots – ECE3087 Basic concepts of IoT and Robots along with the usage and application of IoT as well as Robots.					
Anti-requisites	NIL					
Course Description	The aim of this course is to enable the students to understand the role of IoT in Robots. This course is both conceptual and application based which imparts the control of Robot using IoT. The comprehensive nature of the course covers a number of quizzes based on IoT and Robots so that students may judge themselves.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Summarize the concept of IoT and architecture for Robots 2. Employ various MAC protocol and routing protocols 3. Demonstrate various feature extraction and event detection techniques using time-domain as well as frequency-domain analysis methods. 4. Employ various parametric and non-parametric models of certain physiological systems in IoT based Robots.					
Course Content:						
Module 1	IoT Concept an Implementation	Quiz	Memory Recall based Quizzes	8 Classes		
Topics: Introduction: IoT concepts, Definition, Characteristics, Components of IoT System, IoT Applications, Physical and logical design of IoT , IoT Standards, Relevance of IoT for the future, Challenges in IoT implementation , IoT for Robot, IoT in Indian Scenario, its opportunities.						
Module 2	IoT AND M2M	Assignment / Quiz	Smart objects and Network basics	10 Classes		
Topics: Introduction, M2M, difference between IoT and M2M, software defined networking						

(SDN) and network function virtualization (NFV) for IoT, basics of IoT system management with NETCONF-YANG

Module 3	Introduction to Robots	Assignment	Robots and Classification	10 Classes

Topics: Robots: Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source. Robot anatomy, configuration of robots, joint notation schemes, work volume, position representation, forward and reverse transformations, Factors influencing the choice of a robot, Types of industrial robots Load handling capacity, general considerations in Robotic material handling.

Module 4	Robot Drives and Power Transmission Systems	Assignment		12 Classes

Topics: Robot drive mechanisms: Hydraulic/Electric/Pneumatics, servo & stepper motor drives, Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearings. Robot end Effectors: Classification of End effectors – active and passive grippers. Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

Targeted Application & Tools that can be used:
Application Area is Robot applications by implementing IoT for industrial Robots.
Professionally Used Software:

Project work/Assignment:

Project Assignment:

1. PPT presentation on Introduction to IoT concepts, Applications, use of IoT in Robots
2. PPT presentation on Cloud Computing, Real time analytics, Sensor Networks and other related topics.
3. PPT presentation on Introduction to Robots, Robot Components, Coordinate Systems.
4. PPT presentation on Industrial Robots
5. PPT presentation on Robot 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 development of "EMPLOYABILITY": Use of IoT in Robot

Topics relevant to "GENDER SENISITASATION":

Catalogue prepared by	Dr. Dharmesh Kumar Srivastava
Recommended by the Board of Studies on	BOS 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 Theory	L- T-P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Internet of Things and Biomedical Engineering					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to appreciate the fundamental of Internet of Medical Things and its application in Healthcare Systems. This course is analytical in nature and needs a fair knowledge about basics of IoT related topics. The focus of the course will be to make health facilities accessible to everyone irrespective of their geographical location. Remote monitoring of the patients is one of the significant aspects of IoMT.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Summarize the architectures of IoMT Devices and their system applications. 2. Apply the IoMT Schema for Remote Patient Monitoring. 3. Examine the operation of Block chain Technology for Privacy-Protection of Medical health records. 4. Analyze the data compression methods for lossless Medical Data Transmission.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Internet of Medical Things (IoMT) and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques					
Course Content:						
Module 1	Introduction to IoMT	Quiz	Threats and Challenges of IoMT	12 Sessions		
Topics: Introduction to IoMT, IoMT Devices: On-Body Devices, In-Home Devices, Community Devices, In-Clinic Devices, In-Hospital Devices, IoMT System Architecture: Data Collection Layer, Data Management Layer, Medical Server Layer, IoMT Attack Types, Challenges in IoMT Security Schemes.						
Module 2	Healthcare Schema using IoMT for Remote Patient Monitoring	Assignment	Solution for Storage and Transfer of Medical Data in IoTM	10 Sessions		
Topics: Intelligent Transit Healthcare Schema Using IoMT Networking System: Vibration-Sensing Methodology for Accident Detection, System Safeguards, GPS Integration, Hospital Communication About Accident Location, MCU Connection with the ITH-IoMT Subsystem, GPS-Enabled Module for Location Information, ECG and Health Data Monitoring Schema.						
Module 3	Privacy Protection of IoMT-Based Health Records using Blockchain Technology	Assignment	GPS and GUI based medical data storage in EHR	8 Sessions		
Topics: Introduction to Blockchain, Applications of Blockchain, Blockchain Advantages						

and Challenges, Personal Health Data Collection, Virtual Private Server (VPS)-Based Hyperledger Fabric Framework, Remote Monitoring Software Development				
Module 4	Medical Data Compression for Lossless Data Transmission	Assignment	Compression methods for telemedicine applications	8 Sessions
Topics: Introduction to Medical Data Compression: Lossless Compression , Lossy Compression, Significance of Medical Data Compression, Benefits of Medical Data Compression, Characteristics of Data Acquisition and Storage, Data Compression Techniques for Lossless Data Transmission: Coding Scheme, Bandwidth, Storage and Data Compression Techniques.				
Targeted Application & Tools that can be used: Application: It includes complete Healthcare Automation Setup in Medical field with an objective to make health facilities accessible to everyone irrespective of geographical location. Professionally Used Software: ITM-IoMT System, GPS-GUI System, GPS-Framework uses Global Navigation Satellite System-(GNSS),GPS-gadgets to provide data on location, vehicle speed, time and direction.				
QUIZ/Assignment:				
1. Project/Programming Assignment: Students will be made into group and given the programming assignment at the end of each module. Students need to use GPS-GUI for this assignments. Sample Assignment 1: Study of wearable smart devices for remote healthcare monitoring to detect cardiac diseases. Sample Assignment 2: Smart assistance of elderly individuals in emergency situations at home. 2. Book Review/ Article review: A chapter of a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. Presidency University Library Link:- https://presiuniv.knimbus.com/user#/home Presidency University Library Link . 3. Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.				
Text Book(s): 1. D. Jude Hemanth, J. Anitha George A, Tsihrintzis, *"Internet of Medical Things: Remote Healthcare Systems and Applications"*, 1st Edition, Springer Nature, Switzerland AG 2021, ISSN 2199-1073,ISSN 2199-1081 (electronic), Internet of Things ISBN 978-3-030-63936-5, ISBN 978-3-030-63937-2 (eBook) Internet of Medical Things: Remote Healthcare Systems and Applications - Google Books				
References Reference Book(s) 1. Krishna Singh, Mohammed Elhoseny, Akansha Singh, Ahmed Elngar, "Machine Learning and the Internet of Medical Things in Healthcare", 1st Edition-2021, Elsevier Publication. 2. Qusay Hassan, "Internet of Things A to Z: Technologies and Applications", 1st Edition, The Institute of Electrical and Electronics Engineers, Inc. Published 2018 by John Wiley & Sons. Online resources				

1. Video lectures on "IoT Applications: Healthcare" by Prof. Dr. Sudip Misra, Department of Computer Science and Engineering, IIT Kharagpur. https://www.youtube.com/watch?v=WmlgDL44PG4
2. E-Book, D. Jude Hemanth, J. Anitha George A, Tsihrintzis, "Internet of Medical Things: Remote Healthcare Systems and Applications", 1st Edition, Springer Nature https://doi.org/10.1007/978-3-030-63937-2.
3. e-Book Series on " Internet of Things" by Giancarlo Fortino, Antonio Liotta, 1st Edition, Springer Nature. Electronic ISSN: 2199-1081 , Print ISSN: 2199-1073, http://www.springer.com/series/11636
4. Video lectures on "Introduction to IoT" by Prof. Dr. Sudip Misra, Department of Computer Science and Engineering, IIT Kharagpur, https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-8QzOAHziEgmjQ2qE

E-content:

1. James, Christopher J., and Christian W. Hesse. "Independent component analysis for biomedical signals." Physiological measurement 26, no. 1 (2004): R15. https://www.academia.edu/download/49895521/0967-3334_2F26_2F1_2Fr0220161026-21959-1bfp9y3.pdf
2. Addison, Paul S. "Wavelet transforms and the ECG: a review." Physiological measurement 26, no. 5 (2005): R155. https://people.uwec.edu/walkerjs/primer/Papers/Addison_EEG_Review.pdf
3. Ce Zheng, Malcolm Egan,Laurent Clavier, Gareth W. Peters & Jean-Marie Gorce EURASIP Journal on Wireless Communications and Networking volume 2022, https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w.
4. Jose David Rodriguez Martinez, "A Wearable Platform for Patient Monitoring during Mass Casualty Incidents", 2018. Karlsruhe: KIT Scientific Publishing. DOI: https://doi.org/10.5445/KSP/1000051989
5. Nicola Carbonaro and Alessandro Tognetti, " Wearable Technologies", Printed Edition of the Special Issue Published in Technologies. MDPI BOOK publications. https://www.mdpi.com/books/pdfview/book/1088
6. https://presiuniv.knimbus.com/user#/home

Topics relevant to "SKILL DEVELOPMENT": IoMT devices used for Medical Application and identify the IoMT architectures for Skill Development through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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

Artificial Intelligence Basket

Course Code: ECE3447	Course Title: Computational Intelligence and Machine Learning Type of Course: Discipline Elective-General Basket	L- T-P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of matrix operations, probability theory, vector and array representation.					
Anti-requisites	NIL					
Course Description	The course aims to make the students to understand the mathematical approaches for machine learning and computational intelligence algorithms. This course covers the basic concepts of Neural Networks which will enable the students to understand the concepts of machine learning. Concepts of Linear models for regression and classification will be discussed in such way that students can able to perform data analysis in practical applications. In this course, Computational intelligence algorithms are included to get better understanding of Artificial intelligence.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Computational Intelligence and Machine Learning and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.					
Course Outcomes	On successful completion of the course the students shall be able to: 1. Analyze and fundamental concepts of neural networks 2. Implement ML algorithms to regression, classification, clustering, and dimensionality reduction 3. Categorize the various pattern recognition techniques using machine learning into supervised and unsupervised.					
Course Content:						
Module 1	Fundamentals of ANN	Assignment	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	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	14 *Sessions*		

Topics:
Kernel methods: Dual representations-Constructing kernels, K- means Algorithm, Fuzzy K-means Algorithm, Kohonen Self organizing Maps, Maximum margin classifier (Support Vector Machine), Particle swarm optimization--Ant colony optimization- Bacterial foraging. Genetic algorithm.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: This course is contributed for placement in data science companies, research & development work and also useful to know the existing & developing Artificial Intelligence.
Professionally Used Software: MatLab, Phython

Text Books:
1. Pattern recognition and machine learning, Christopher M. Bishop, TMH, Springer, 2010
2. Algorithm Collections for Digital Signal Processing Applications Using Matlab, E.S. Gopi, Springer.

Reference(s):
Reference Books
1. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020.

Online Resources (e-books, notes, ppts, video lectures etc.):
1. https://youtube.com/playlist?list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77
2. https://archive.ics.uci.edu/ml/index.php

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

E-content:
1. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu, Lin Ye,
A review of the application of machine learning in water quality evaluation, Eco-Environment & Health,
2022, ISSN 2772-9850,
https://doi.org/10.1016/j.eehl.2022.06.001.

2. Lin Li, Yici Cai, Qiang Zhou, A survey on machine learning-based routing for VLSI physical design,
Integration, Volume 86, 2022, Pages 51-56, ISSN 0167-9260,
https://doi.org/10.1016/j.vlsi.2022.05.003.

3. Vijaya B. Kolachalama, Machine learning and pre-medical education, Artificial Intelligence in Medicine,
Volume 129, 2022, 102313, ISSN 0933-3657,
https://doi.org/10.1016/j.artmed.2022.102313.

4. Sergio Ledesma, Mario-Alberto Ibarra-Manzano, Dora-Luz Almanza-Ojeda, Juan Gabriel Avina-Cervantes, Eduardo Cabal-Yepez, On removing conflicts for machine learning, Expert Systems with Applications,
Volume 206, 2022, 117835, ISSN 0957-4174,
https://doi.org/10.1016/j.eswa.2022.117835

Topics relevant to "EMPLOYABILITY SKILLS": Artificial Neural Networks, Learning Algorithms, linear regression for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. G Tirumala Vasu

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

Course Code: ECE3448	Course Title : Neural Networks and Deep Learning Type of Course: Discipline Elective- General Basket	L-T- P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NA					
Anti-requisites	NIL					
Course Description	The purpose of this course is to teach the 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.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Neural Networks and Deep Learning and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING.					
Course Outcomes	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					
Course Content:						
Module 1	Introduction To Neural Networks	Quiz and assignments	10 SESSION			
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						
Module 2	Convolutional Neural Network	assignments	10 SESSION			
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-						
Module 3	Deep Learning	Quiz and assignments	10 SESSION			
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.

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

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:

1. Sergiu Oprea , Pablo Martinez-Gonzalez, Alberto Garcia-Garcia , John Alejandro Castro-Vargas, Sergio Orts-Escolano , Jose Garcia-Rodriguez , and Antonis Argyros, (2022, June). A Review on Deep Learning Techniques for Video Prediction. IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 44, NO. 6 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9294028
2. Qin Zou , Member, IEEE, Lihao Ni , Tong Zhang , and Qian Wang, "Deep Learning Based Feature Selection for Remote Sensing Scene Classification". In IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 12, NO. 11, NOVEMBER 2015. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7272047
3. Tsung-Han Chan, Kui Jia, Shenghua Gao, Jiwen Lu, Zinan Zeng, and Yi Ma, " PCANet: A Simple Deep Learning Baseline for Image Classification?", in IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 24, NO. 12, DECEMBER 2015 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7234886
4. Dionysis Goularas; Sani Kamis, "Evaluation of Deep Learning Techniques in Sentiment Analysis from Twitter Data" 2019, *International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*. https://ieeexplore.ieee.org/xpl/conhome/8870906/proceeding

Topics relevant to "EMPLOYABILITY SKILLS": Deep Learning, Neural network, Reinforcement Learning for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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. 16th , Dated 23/10/2021

Course Code: ECE3451	Course Title: AI & Digital Health Type of Course: Discipline Elective- AI Basket		L-T-P-C	3	0	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: 1. Explain basic principles of AI & Digital Health. 2. Understand the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning. 3. Illustrate object-oriented concepts. 4. Develop database and GUI applications.					
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: 1. https://www.coursera.org/learn/introduction-to-digital-health 2. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-947-medical-artificial-intelligence-spring-2005/ 3. https://www.mtu.edu/gradschool/programs/certificates/ai-healthcare/
References: R1: Artificial Intelligence in Health Care System, by Amar Shukla & Lalit Kane, Nitya Publications R2: The Digital Health Revolution, by Kevin Pereau; Publisher :Transcendit Health
E-Content 1. Yu, Kun-Hsing, Andrew L. Beam, and Isaac S. Kohane. "Artificial intelligence in healthcare." *Nature biomedical engineering* 2, no. 10 (2018): 719-731. 2. Noorbakhsh-Sabet, Nariman, Ramin Zand, Yanfei Zhang, and Vida Abedi. "Artificial intelligence transforms the future of health care." *The American journal of medicine, Elsevier,* 132, no. 7 (2019): 795-801. 3. Ghazal, Taher M. "Internet of things with artificial intelligence for health care security." *Arabian Journal for Science and Engineering, Springer nature* (2021): 1-12. 4. Mansour, Romany Fouad, Adnen El Amraoui, Issam Nouaouri, Vicente García Díaz, Deepak Gupta, and Sachin Kumar. "Artificial intelligence and internet of things enabled disease diagnosis model for smart healthcare systems." *IEEE Access* 9 (2021): 45137-45146.
Topics relevant to "EMPLOYABILITY SKILLS": Health assistance and administration Patient management, Precision medicine, Supporting pharma: drug creation and clinical trials, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout. Patient management Precision medicine, Supporting pharma: drug creation and clinical trials

Catalogue prepared by	Dr. Pritam Keshari Sahoo and Dr.Ashutosh Anand

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

Course Code: ECE3452	Course Title: Natural Language Processing Type of Course: Open Elective Theory only	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Prior exposure to discrete math, probability, linear algebra, optimization, linguistics, artificial intelligence, machine learning and familiarity with python will be useful but not required					
Anti-requisites	NIL					
Course Description	This course is intended as a theoretical and methodological introduction to the most widely used and effective current techniques, strategies and toolkits for natural language processing, with a primary focus on those available in the Python programming language through programming and simulation.					
Course Objective	This course is designed to develop Entrepreneurial skills by using Experiential Learning Techniques					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Understand basics in natural language processing methods and strategies. (2) Evaluate the strengths and weaknesses of various NLP technologies and frameworks (3) Employ literary-historical NLP-based analytic techniques like stylometry, topic modeling, synsets and named entity recognition.					
Course Content:						

Module 1	Syntactic Processing	Assignment	Programming and Simulation task	09 Sessions
Topics: Introduction, Linguistic Background, Grammars and Parsing, Features and Augmented Grammars, Grammars for Natural Language, Toward Efficient Parsing, Ambiguity Resolution: Statistical Methods				
Module 2	Semantic Interpretation	Assignment	Programming and Simulation task	11 Sessions
Topics: Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity Resolution, Other Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases.				
Module 3	Context and World Knowledge	Assignment	Programming and Simulation task	10 Sessions
Topics: Knowledge Representation and Reasoning, Local Discourse Context and Reference, Using World Knowledge, Discourse Structure, Defining a Conversational Agent				
Module 4	INFORMATION RETRIEVAL AND LEXICAL RESOURCES:	Assignment	Programming 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

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/9332458Other Resources: Presidency University Library Link https://presiuniv.knimbus.com/user#/home	
Topics relevant to development of "FOUNDATION SKILLS":	
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

Open Eletives

Course Code: ECE3801	Course Title: Microprocessor based Systems Type of Course: Open Elective &Theory Only	L-T-P-C	3	0	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.):
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:
19. 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
20. 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
21. 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
22. 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
23. 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: ECE3802	Course Title: Artificial Neural Networks Type of Course: Open Elective Theory	L- T-P- C	3	0	0	3
Version No.	1.0					
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

<table>
<tr><td>Course Code: ECE3803</td><td colspan="2">Course Title: Smart Electronics in Agriculture
Type of Course:</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">Basic concepts assembly programming and embedded C, Understanding of interfacing Memory and peripherals.</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 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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL 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) 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.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="2">Component of Agriculture</td><td>QUIZ</td><td colspan="2">Comprehension level Quiz</td><td>12 classes</td></tr>
<tr><td colspan="8">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</td></tr>
</table>

system Functional framework for edge-based agricultural system Benefits and challenges. IoT fundamentals and its applications devices for smart agriculture. Precision agriculture Hydroponics.				
Module 2	Smart electronic for Agriculture	Case Study	Sensor and Embedded system	15 classes
Topics: Sensors and actuator for agriculture, smart embedded systems, understanding Arduino Boards, Programming and Interfacing. Selection of Embedded Platform. IoT technology Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud. Iot Accessing technology- IEEE 802.15.1,IPV4 and IPV6 Addressing IoT nodes, IoT Edge, MQTT, AMQP, COAP Interfacing RFID and Sensors and Actuators through Protocols				
Module 3	Cloud Based IoT Applications	Mini Project	System Design Task and Analysis	12 Classes
Topics: The Internet of Things in agriculture for sustainable rural development. Internet of Things (IoT) in agriculture toward urban greening. Smart e-agriculture monitoring systems , smart agriculture using renewable energy and AI-powered IoT. Surveying smart farming for smart cities, Farm Automation. A fog computing-based IoT framework for prediction of crop disease using big data analytics Agribots: A gateway to the next revolution in agriculture, Transforming IoT in aquaculture: A cloud solution				
Targeted Application & Tools that can be used: Important Applications range from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IOT Professionally Used Software: Kiel, C and Python				
Project work/Assignment:				
1.Case Studies: At the end of the course students will be given a 'real-world' application based circuits like Power Amplifier, Signal/Function Generator etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format. 2. Book/Article review: At the end of each module a book reference or an article topic will be given to each student. They need to visit the library and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link . 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same. 4.Assignment:Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples. Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate. Assignment: 2] Design a IOT based application for A. Climate condition monitoring and automated systems B. Internet of Things on sustainable aquaculture system C. IoT-based monitoring system for freshwater fish farming: Analysis and design D. Design a IoT based agricultural system for optimal management				
Textbook(s): 1. Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu				

Kumar Pani "AI, Edge and IoT-based Smart Agriculture "1st Edition November 10, 2021

2. Prasant Kumar Pattnaik, Raghvendra Kumar, S. N. Panda, Souvik Pal " IoT and Analytics for Agriculture"2020

References

1.. Arshdeep Bagha & Vijay Madisetti, " Internet of Things a Hands on Approach"

2. Adrian McEwen & Hakim Cassimally "Designing the Internet of Things".

3.IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

E-Content:-

1. Vijaya Saraswathi R, Sridharani R,Saranya chowdary P ,Nikhil K Smart Farming: The IoT based Future Agriculture 2022 4th International Conference on Smart Systems and Inventive Technology (ICSSIT) 25 February 2022

   Smart Farming: The IoT based Future Agriculture | IEEE Conference Publication | IEEE Xplore

2. Cheena Sharma and Naveen Kumar Gondhi 2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU) 23-24 Feb. 2018Communication Protocol Stack for Constrained IoT Systems.

   https://ieeexplore.ieee.org/document/8519904/authors#authors

3. Bertha Mazon-Olivo and Alberto Pan IEEE Latin America Transactions 1 Jan.-2022 Internet of Things: State-of-the-art, Computing Paradigms and Reference Architectures.

   https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9662165

4 Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International Conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.

   https://ieeexplore.ieee.org/document/8439638

5 Introduction To Internet Of Things - Course (nptel.ac.in)

Topics relevant to development of "Emplobility": The Internet of Things in agriculture for sustainable rural development.
Internet of Things (IoT) in agriculture toward urban greening. Topics relevant to development of "Entrepreneurship" : Smart e-agriculture monitoring systems , AI-powered IoT. Surveying smart farming for smart cities, Farm Automation.

Catalogue prepared by	Ms.Renuka Bhagwat
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2022

Date of Approval by the Academic Council	Academic Council Meeting No. 18, Dated 3/8/2022

Course Code: ECE3804	Course Title: Environment Monitoring system Type of Course: Open Elective	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	Internet of Things					
Course Description	This course provides fundamental concepts of various environment monitoring eco systems. It provide students with deep knowledge of sensors and data acquisition systems to monitor atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems. The course also provides students with deep knowledge of importance of single board computers and data loggers.					
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe the concepts of continuous real time monitoring systems with Internet of Things. (2) Understand constraints and opportunities of single board computers. (3) Describe the various setup to monitor and measure the data collected from environment. (4) Able to design and perform experiments on sensors and develop the projects based on the customer needs.					
Course Content:						
Module 1	Introduction	Quiz	Memory Recall based Quizzes	10 Sessions		
Topics: Environmental systems,Echo systems and planet earth.Human Interaction with the environment, from measuring to knowing, continuous real time monitoring,data management and World Wide Web. Sampling,Ground based,airborne and spaceborne systems.						
Module 2	From Sensors to systems.	Assignment / Quiz	Memory Interfacing Task and Analysis	12 Sessions		
Topics: Sensors and transducers: Principles of electrical quantities, circuits,sensor specifications, from sensors to transducers, case studies:from light sensors to a light transducers, from thermistor to temperature tranducers,temperature transducres for air,soil and water.Thermocouples,using thermocouples.						
Module 3	Data Acquisition	Assignment	Memory Interfacing Task and Analysis	10 Sessions		

	systems			
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.

Project work/Assignment:

1. Mini Projects: At the end of the course students will be assigned a project work on solving many environmental monitoring issues in real time.

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

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

Textbook(s):

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.):

24. 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 >
25. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088 >
26. Case studies on Wearable technology< https://www.hticiitm.org/wearables>

E-content:

8. Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ISBN-13: 978-1882417087.

9. 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.

10. 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.

11. F. Sánchez-Rosario *et al*., "A low consumption real time environmental monitoring system for smart cities based on ZigBee wireless sensor network," *2015*, pp. 702-707, doi: 10.1109/IWCMC.2015.7289169. https://ieeexplore.ieee.org/document/7289169.

Topics relevant to development of "SKILL": System design for environmental monitoring systems.

Catalogue prepared by	Dr. Divya Rani
Recommended by the Board of Studies on	BOS 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: ECE3805	Course Title: Consumer Electronics Type of Course: Open Elective	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basics of Electronics					
Anti-requisites	NIL					
Course Description	This course is designed to enhance the knowledge, skills and attitude in performing testing assembling/disassembling of electronic components, maintaining and repairing audio/video products and systems, terminating/connecting electrical & electronics circuit and maintaining and repairing electrically-controlled domestic appliance .It also covers Computer operation with internet browsing, industry control system, Color TV, LCD, LED,CD VCD, DVD, IPS, UPS, cellular phone, House hold appliance and using specialized equipment repair and commissioning of consumer electronic products and systems.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the devices and system functions 2. Classify the components in electronics 3. Demonstrate and explain the house hold appliances					
Course Content:						
Module 1	Audio Fundamentals, Devices & Systems	Assignment/ Quiz	Memory Recall based Quizzes	15 Sessions		
Topics: Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types. Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types.						
Module 2	Television Fundamentals	Assignment/ Quiz	Real time Application Project	15 Sessions		
Topics: Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution, Composite video signal, Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance, Different types of TV camera, Transmission standards. PAL-D colour TV receiver, Digital TVs:- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver, Video interface, Digital Video, SDI, HDMI Multimedia Interface , Digital Video Interface, CD and DVD player.						
Module 3	Home / Office Appliances	Assignment/ Quiz	Memory Recall based	10 Sessions		

			Quizzes	

Home Appliances: Inverter, Microwave oven, Domestic Refrigerator, Controls in Refrigerator, Room Air Conditioning.
Office Appliances : Calculator, Facsimile (FAX) and Pager.

Targeted Application & Tools that can be used:

Consumer Electronics appear in a variety of application in repairing the electrical, electronic components and devices, repair of consumer house hold appliances

Professionally Used Software: Multisim

Project Work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' application based on consumer electronics. Students will be submitting a report on the same which will include in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link .
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
4. Project Assignments:

Consumer electronic products are invariably covered by a 'Manufacturer's Warranty' which offers the purchaser some protection against detective workmanship and component failure during a limited term.
Assignment 1: Device control using Smart Phone's Bluetooth
Assignment 2: Stereophonic Acoustic Echo Suppression for Speech Interfaces for Intelligent TV Applications.

Text Book(s):

1. Bali.S.P, "*Consumer Electronics*", Pearson Education India,2010 , latest edition

Reference(s):
Reference Book(s):

R1 Bali R and Bali S.P, "A*udio video systems : principle practices & troubleshooting*", Khanna Book Publishing Co. (P) Ltd., 2010Delhi , India, latest edition

R2 Gulati R.R., "*Modern Television practices*", New Age International Publication (P) Ltd. New Delhi Year 2011, latest edition.

R3 Gupta R.G. *"Audio video systems",* Tata Mc graw Hill, New Delhi, India 2010, latest editio

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

1. https://nptel.ac.in/courses/117108140
2. https://en.wikipedia.org/wiki/Consumer_electronics

E-content:

1. H. Hoang, S. Lee, Y. Kim, Y. Choi and F. Bien, "An adaptive technique to improve wireless power transfer for consumer electronics," in IEEE Transactions on Consumer Electronics, vol. 58, no. 2, pp. 327-332, May 2012, doi:

10.1109/TCE.2012.6227430.
2. L. Morra, S. P. Mohanty and F. Lamberti, "Artificial Intelligence in Consumer Electronics," in IEEE Consumer Electronics Magazine, vol. 9, no. 3, pp. 46-47, 1 May 2020, doi: 10.1109/MCE.2019.2962163. https://ieeexplore.ieee.org/abstract/document/9055488
3. F. Pieri, C. Zambelli, A. Nannini, P. Olivo and S. Saponara, "Is Consumer Electronics Redesigning Our Cars?: Challenges of Integrated Technologies for Sensing, Computing, and Storage," in IEEE Consumer Electronics Magazine, vol. 7, no. 5, pp. 8-17, Sept. 2018, doi: 10.1109/MCE.2017.2771515.

Topics relevant to the: "FOUNDATION SKILLS", Television fundamentals with their applications.
Topics relevant to the:" EMPLOYABILITY", Home / Office Appliances .

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

Course Code: ECE3806	Course Title: Product Design of Electronic Equipment Type of Course: Open Elective Theory only	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of this course is to give the students the opportunity to improve their design abilities for some well-known consumer electrical goods. Basic circuit configurations for many different electronic goods are covered throughout the course. By taking into account their electrical, mechanical, ergonomic, and aesthetic design aspects, the students will be able to design and develop various electronic components. The course's thoroughness includes a variety of tests, computer-aided design-based tools, and mockup-based projects that help students develop their talents to work independently as product design engineers.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING technique for designing various electronic products					
Course Outcomes	On successful completion of this course the students shall be able to: (1) Outline various electronic products and their design considerations. (2) Discuss PCB design and fabrication flow.. (3) Report ergonomic, aesthetic and packaging requirements of electronic products. (4) Discover safety and reliability issues and compliance requirement in electronic products design.					
Course Content:						
Module 1	Overview of Electronic Products and Product Design Considerations	Quiz	Memory Recall based Quizzes	10 Classes		
Topics: Audio Systems; Video Systems and; Domestic & Consumer; Air-conditioners and Refrigerators; Computers office Systems; Telephone & Mobile Radio Systems.						
Module 2	PCB Design and Manufacturing	Assignment / Quiz	Programming and Simulation task	12 Classes		

Topics:
Power Supply Design – Basic circuit configurations, Regulators, Switching Regulators, Switch Mode Power Supply, PWM Control methods; CAD Tools for PCB Design – Design Rules, Schematic, Simulation, Netlist Import, Place and Route, Advance PCBs; PCB Fabrication Process; Electromagnetic Interference (EMI) – EMC and EMI, EMI Reduction and Shielding.

Module 3	Ergonomics and Packaging for Electronic Products	Assignment	Mock up Design and Analysis Tasks	10 Classes

Topics:
Ergonomics and Aesthetics in Electronic Product Design – Overview of Ergonomics and Aesthetics in for Electronic Products, issues in placement and integration various electronic components; Packaging, Enclosures and Cooling of Electronic Systems; 3D Printing and Computer Aided Design.

Module 4	Product Safety and 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

Project work/Assignment:

1. Case Studies: At the end of the course students will be given a 'real-world' product design design case studies. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. and/or a mock-up model in appropriate format.

2. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. <https://presiuniv.knimbus.com/user#/home >.
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.

Project Assignment: Carry out various design and analysis task for various consumer electronics products.

Assignment: 1] Simulate and design the layout of an audio amplifier PCB..

Assignment 2: Prepare a mockup model of an electronic product by considering ergonomic and aesthetic issues in mind (e.g. a new mouse, a new table lamp, an audio device etc.)

Textbook(s):

1. Bali, S. P. *Consumer Electronics*. Pearson Education India, 2007.
2. Mitzner, Kraig. *Complete PCB design using OrCad capture and layout*. Elsevier, 2011.

Reference(s):
Reference Book(s):

1. Mitzner, Kraig. *Complete PCB design using OrCad capture and layout*. Elsevier,

2011.
2. Reis, Ronald A. "Electronic project design and fabrication." (1989).
3. Bagad, V. S. *Electronics Product Design*. Technical Publications, 2009.
4. Ohring, Milton, and Lucian Kasprzak. *Reliability and failure of electronic materials and devices*. Academic Press, 2014.
5. O'Connor, Patrick, and Andre Kleyner. *Practical reliability engineering*. John Wiley & Sons, 2012.

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

19. 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
20. 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
21. 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
22. 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:

27. 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
28. 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
29. 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
30. 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
31. 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
32. 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
33. 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 "EMPLOYABILITY": Working Principles of various electronic consumer products, PCB Design.

Topics relevant to development of "ENVIRONMENT AND SUSTAINABILITY SKILLS": Types of materials and wastes produced during fabrication processes as well as discarded electronic waste.	
Catalogue prepared by	Dr. Rajiv Ranjan Singh
Recommended by the Board of Studies on	BOS NO: 15th BOS held on 28/07/2021
Date of Approval by the Academic Council	Academic Council Meeting No. 18th , Dated 03/08/2022

<table>
<tr><td>Course Code: ECE3807</td><td colspan="4">Course Title: Introduction to Data Analytics
Type of Course: Open Elective Theory</td><td>L- T- P- C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="9">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="9">Probability and Statistics</td></tr>
<tr><td>Anti-requisites</td><td colspan="9">NIL</td></tr>
<tr><td>Course Description</td><td colspan="9">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.</td></tr>
<tr><td>Course Objective</td><td colspan="9">This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="9">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.</td></tr>
<tr><td>Course Content:</td><td colspan="9"></td></tr>
<tr><td>Module 1</td><td>Introduction to Data Analytics</td><td>Quiz/Assignment</td><td>Memory Recall based Quizzes/Assignments</td><td>6 classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 2</td><td>Introduction to the Python’s World- Plotting and Visualization</td><td>Quiz/Assignment</td><td>Programming, Analysis and Visualization</td><td>8 classes</td></tr>
<tr><td colspan="5">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.</td></tr>
</table>

Module 3	Statistics, data, and Statistical Thinking	Assignment	Programming, Analysis and Visualization	8 classes

Topics:
Describing Qualitative Data, Numerical Measures of Central Tendency, using the Mean and Standard Deviation to Describe Data, Methods for Detecting Outliers: Box Plots and z-Scores, Types of Random Variables, Probability Distributions for Discrete Random Variables, Expected Values of Discrete Random Variables, The Binomial Random Variable, The Poisson Random Variable, Statistical inference, Bias, The method of moments, Least squares/weighted least squares, Maximum likelihood

Module 4	Machine Learning with scikit-learn	Assignment	Programming, Analysis and Visualization	9 classes

Topics:

The scikit-learn Library, Supervised Learning with scikit-learn, The Iris Flower Dataset, K-Nearest Neighbors Classifier, Linear Regression, The Least Square Regression, Support Vector Machines (SVMs)

Project work/Assignment:

1. Project: At the end of the course, students will be given a 'real-world' data analytics application based topic as a project. Students will be submitting a report, which will include different steps of data cleaning and preparation, plotting and visualization and Results of the analysis etc. in appropriate format.

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

3. Assignments:

Assignment 1: Using Python programming, the students are required to analyze loan application data.

Assignment 2: Using Python programming, the students are required to analyze stock price data and perform different steps of data cleaning and preparation, plotting and visualization

Textbook

T1. Wes McKinney, "Python for Data Analysis: Data Wrangling With Pandas, Numpy, And Ipython", O'Reilly Publications, 2017

T2. Fabio Nelli, "Python Data Analytics Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language", Apress.

References

R1. Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.

R2. Leonard Kaufman, Peter J. Rousseeuw (1990). Finding Groups in Data:

An Introduction to Cluster Analysis. "John Wiley & Sons, Inc". Topics for Technology Enabled Learning: 1. Data Analysis with Python | Coursera, Offered by IBM https://www.coursera.org/professional-certificates/ibm-data-analyst 2. Data Analytics with Python - NPTEL Online Courses, by Prof. A Ramesh | IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_cs45/preview 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 "HUMAN VALUES &PROFESSIONAL ETHICS": Concepts of Data collection and analysis for an assignment.

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

Course Code: ECE3808	Course Title : Machine Vision for Robotics Type of Course: Theory	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NA					
Anti-requisites	NIL					
Course Description	The purpose of this course is to teach the principles and applications of vision system in modern manufacturing Environment. The nature of this course is analytical with practical understanding. It is also intended at introducing basic concepts to Non ECE and CSE students. The course is analytical in nature and needs fair knowledge of digital image processing. The first part of the course focuses the basics vision systems and object recognition. Further, it explores the knowledge in robot vision applications.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 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	Quizzes and assignments				12 SESSION
Topics: Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interface- Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction- Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values.						
Module 2	Vision algorithms and applications	Quizzes and assignments				12 SESSION
Topics: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.						
Module 3	ROBOT Vision	Quizzes and assignments				12 SESSION
Topics: Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package						
Targeted Application & Tools that can be used: Application Area includes all intelligence devices like Unmanned Vehicle. The students will be able to join a profession which involves basics to high level of automation design and analysis. Professionally Used Software: PYTHON, MATLAB, JAVA. PyTorch, AWS cloud, Torch, Keras,						

TensorFlow-IBM Watson

Project work/Assignment:

1.Case Studies: At the end of the course students will be given a real-world scenario for any application like, Drive the solution of a shape-from-shading problem at a singular point, by fitting a smooth local shape near the singular point. Students will be submitting a report which will include Design and implementation methodology.

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

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

4.Assignment 1:) Consider a flying robotic system that uses binocular stereo to obtain three dimensional information from pairs of images. Suppose that the scale of the recovered three dimensional coordinates is not known accurately because the baseline between exposure stations is not known with precision. Now suppose that two such three-dimensional models — obtained along different flight paths — are to be related. In this case, determining the absolute orientation requires that, in addition to translation and rotation, a scale factor relating the two three dimensional models be found as well.

Text Book(s):

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 on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

Course Code: ECE3800	Course Title: Fundamentals of Electronics Type of Course: School Core Theory		L-T-P-C	3	0	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

MAC Basket

Course Code: PPS 1025	Course Title: Industry Readiness Program – I (Audited Course) Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	• Students are expected to understand Basic English. • Students should have desire and enthusiasm to involve, participate and learn.					
Anti-requisites	NIL					
Course Description	This course is designed to enable students to set SMART goals, form professional & personal ethics for success and learn various email writing techniques. The course will benefit learners in presenting themselves effectively through various activities and learning methodologies.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Employability for Young Professionals" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: CO 1 Define their career goals CO 2 Practice ethical habits for better career success CO3 Demonstrate effective email writing techniques					
Course Content						

Module 1	Goal Setting & Grooming	Classroom activities	10 Hours
Topics: SMART Goals, formal grooming through self-introduction activity Activity: Real world scenarios			

Module 2	Habit Formation	Role plays	10 Hours
Topics: Professional and Personal ethics for success and activity-based practice Activity: Students to present 2 min video on building professional ethics			
Module 3	Email Etiquettes	Individual and group presentation	10 Hours
Topics: Types of prompts to generate effective or desired results for email etiquettes Activity: Individual student presenting various search prompts			
Faculty: L&D			
Targeted Application & Tools that can be used: 1. TED Talks 2. You Tube Links 3. Activities			
Assignment proposed for this course Assignment 1: SMART Goal Assignment 2: AI tools for prompt search			
Continuous Individual Assessment Module 1: Presentation Module 2: Activity based assessment Module 3: Class assessment			

Course Code: PPS1026	Course Title: Industry Readiness Program – II (Audited Course) Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	• Students are expected to understand Basic English. • Students should have desire and enthusiasm to involve, participate and learn.					
Anti-requisites	NIL					
Course Description	This course is designed to enable students learn styles of communication, team building and use empathy in leadership. The course will benefit learners in preparing themselves effectively through various activities and learning methodologies.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Industry Readiness for Young Professionals" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.					
Course Out Comes	On successful completion of this course the students shall be able to: CO 1 Apply different communication skills for success in workplace CO 2 Practice team building skills for career success CO3 Demonstrate ethical leadership skills in workplace					
Course Content						

Course Code: APT4002	Course Title: Introduction to Aptitude (Audited)	L- P- C	0	2	0
Version No.	1.0				
Course Pre-requisites	Students should know the basic Mathematics & aptitude along with understanding of English				
Anti-requisites	Nil				
Course Description	The objective of this course is to prepare the trainees to tackle the questions on various topics and various difficulty levels based on Quantitative Ability, and Logical Reasoning asked during the placement drives. There will be sufficient focus on building the fundamentals of all the topics, as well as on solving the higher order thinking questions. The focus of this course is to teach the students to not only get to the correct answers, but to get there faster than ever before, which will improve their employability factor.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Aptitude and attain Skill Development through Problem Solving techniques.				
Course Outcomes	On successful completion of the course the students shall be able to: CO1] **Recall** all the basic mathematical concepts they learnt in high school. CO2] **Identify** the principle concept needed in a question. CO3] **Solve** the quantitative and logical ability questions with the appropriate concept. CO4] **Analyze** the data given in complex problems. CO5] **Rearrange** the information to simplify the question				
Course Content:					
Module 1	Quantitative Ability	Assignment	Bloom's Level : Application		**12 Hours**
Topics: Introduction to Aptitude, working of Tables, Squares, Cubes					
Module 2	Logical Reasoning	Assignment	Bloom's Level : Application		**18 Hours**
Topics: Linear & Circular Arrangement Puzzle, Coding & Decoding, Blood Relations, Directions, Ordering and Ranking, Clocks and Calendars, Number Series, Wrong number series, Visual Reasoning					

Targeted Application & Tools that can be used: Application area: Placement activities and Competitive examinations. Tools: LMS	
Text Book 1. Quantitative Aptitude by R S Aggarwal 2. Verbal & Non-Verbal Reasoning by R S Aggarwal	
References 1. www.indiabix.com 2. www.youtube.com/c/TheAptitudeGuy/videos	
Topics relevant to Skill development: Quantitative and reasoning aptitude for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	L&D Department faculty members
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code:

APT4004</td><td colspan="2">Course Title: Aptitude Training-Intermediate

Type of Course: Practical Only Course</td><td>L- T - P- C</td><td>0</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td>Version No.</td><td colspan="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">Students should have the basic concepts of Quantitative aptitude along with its applications in real life problems.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">This is a skill-based training program for the students. This course is designed to enable the students to enhance their skills in Quantitative Aptitude.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of Aptitude and attain Skill Development through Problem Solving techniques.</td></tr>
<tr><td>Course Out Comes</td><td colspan="7">On successful completion of this course the students shall be able to:

CO1: Recall all the basic mathematical concepts.

CO2: Identify the principle concept needed in a question.

CO3: Solve the quantitative and logical ability questions with the appropriate concept.

CO4: Analyze the data given in complex problems.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td colspan="3">Quantitative Ability 1</td><td colspan="2">Assignment</td><td colspan="2">16 Hours</td></tr>
<tr><td colspan="8">Topics:

Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss</td></tr>
<tr><td>Module 2</td><td colspan="3">Quantitative Ability 2</td><td colspan="2">Assignment</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="8">Topics:
Time Speed and Distance, Boats and Streams, Simple Interest, Compound Interest, Probability, Permutation and Combination</td></tr>
<tr><td colspan="8">Targeted Application & Tools that can be used:
Application area: Placement activities and Competitive examinations.
Tools: LMS</td></tr>
<tr><td colspan="8">Continuous Evaluation:</td></tr>
</table>

CA1 – Online Test CA2 – Online Test CA3 – Online Test Assignment	
Text Book: 1. Fast Track Objective by Rajesh Verma 2. R S Aggarwal 3. Rakesh Yadav References: **1.** www.indiabix.com **2.** www.testbook.com **3.** www.youtube.com/c/TheAptitudeGuy/videos	
Topics relevant to Skill Development: Quantitative aptitude for Skill Development through Problem solving Techniques. This is attained through components mentioned in course handout.	
Catalogue prepared by	Faculty of L&D
Recommended by the Board of Studies on	BOS held on
Date of Approval by the Academic Council	Academic Council Meeting held on

Course Code: APT4006	Course Title: Logical and Critical Thinking Type of Course: Audited	L- T-P-C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	Students should have the basic concepts of Logical reasoning and Critical thinking, along with its applications in real life problems.					
Anti-requisites	Nil					
Course Description	This is a skill-based training program for the engineering students (Undergraduate). This course is designed to enable the students to enhance their skills in Logical reasoning and Critical thinking.					
Course Objective	The objective of the course is to familiarize the learners with concepts in in Logical reasoning and Critical thinking through problem solving techniques suitable for their career development.					
Course Outcomes	On successful completion of the course the students shall be able to:					
	CO1] Understand all the concepts.					
	CO2] Apply the concepts in problem solving (Bloom's taxonomy Level 3)					
	CO3] Analyze and structure the reasoning techniques and spatial visualization skills					
Course Content:						
Module 1	Logical Thinking	Assignment		16 Hours		
	Topics:					
	Syllogisms, Cubes and Dices, Mirror and Water images, Paper cutting and Folding, Embedded figures & Completion of figures, Data Interpretation, Data sufficiency					
Module 2	Critical Thinking	Assignment		14 Hours		
	Topics:					
	Analogy, Symbol and Notations, Statement and assumption, Cause of action, Statement and conclusion, Puzzles					
	Targeted Application & Tools that can be used:					
	Application area: Placement activities and Competitive examinations.					
	Tools: LMS					
Evaluation	Continuous Evaluation					
	· Topic wise evaluation					
	· Internal Assessments					
	Text Book					
	1. A new approach to reasoning verbal, non-verbal & analytical by BS Sijwali					

	2. R S Aggarwal
	3. Kiran publications
	References
	1. www.indiabix.com
	2. www.testbook.com
	3. www.youtube.com/c/TheAptitudeGuy/videos
	Topics relevant to Skill Development Logical reasoning and Critical thinking for Skill Development through Problem solving Techniques. This is attained through assessment component mentioned in course handout.
Catalogue prepared by	L&D Department Faculty Member
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	