PRESIDENCY SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Program Regulations and Curriculum

2026-2030

BACHELOR OF TECHNOLOGY (B.Tech.) in

VLSI

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

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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)

2.1 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.

2.2 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 2.5) shall be clearly defined in the Course Plan for every Course, and approved by the DAC.

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

2.4 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.

2.5 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.

2.6 Minimum Performance Criteria:

2.6.1 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.

2.6.2 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.

2.6.3 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 2.6.1, 2.6.2 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:

3.1 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.

3.2 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.

3.3 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:

3.3.1 A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause 3.3 (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.

3.3.2 SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 3.3 (as per academic regulations) shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.

3.3.3 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.

3.3.4 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.

3.3.5 A student shall request for transfer of credits only from such approved Courses as mentioned in Sub-Clause 3.3.2 above.

3.3.6 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.

3.3.7 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.

3.3.8 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

3.3.9 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.

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

3.4 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) 2026-2030: 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	ENG1030	Fundamentals of Communication	1	0	2	2
2	ENG2030	Communication in Practice	1	0	2	2
3	APT4005	Aptitude for Employability	0	0	2	1
4	PPS3018	Preparedness for Interview	0	0	2	1
5	FIN1005	Finance Essentials for Decision Making	3	0	0	3
	Total No. of Credits					9

Table 3.2 : List of Basic Science Courses (BSC)						
S.No	Course Code	Course Name	LL	TT	P	CC
1	MAT1211	Linear Algebra, Differential Equations and Statistical Methods	3	1	0	4
2	MAT1213	Differential Equations, Complex Variables and Fourier Series	3	1	0	4
3	MAT2312	Transforms techniques and Vector Calculus for Communication Systems	3	1	0	4
4	MAT2322	Partial Differential Equations and Numerical Methods for Communication Systems	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	EEE1251	Basics of Electrical and Electronics Engineering Lab	0	0	2	1
5	ECE1512	Design Thinking in Practice	2	0	2	3

6	CSS2280	C Programming and Data Structures	3	0	0	3
7	CSS2281	C Programming and Data Structures Lab	0	0	4	2
8	CSS2264	Essentials of AI	3	0	0	3
9	CSS2265	Essentials of AI Lab	0	0	2	1
10	CSS1500	Computational Thinking Using Python	2	0	2	3
	Total No. of Credits					23

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	ECE2023	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	CSS2257	Computer Organization and Architecture	3	0	0	3
7	ECE2509	Solid State Electronics	3	0	0	3
8	ECE2536	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 Engineering	3	0	0	3
15	ECE2522	CMOS VLSI Design	3	0	0	3
16	ECE2572	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	0	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	Linear Algebra for Communication Engineering	3	0	0	3
8	ECE3207	Fuzzy Logic and its Engineering Applications	3	0	0	3
Signal Processing Basket						
1	ECE3400	Speech Signal Processing	3	0	0	3
2	ECE3401	Digital Image Processing	3	0	0	3
3	ECE3402	Biomedical Signal Processing	3	0	0	3
4	ECE3403	Adaptive Signal Processing	3	0	0	3
5	ECE3404	Multimedia Signal Processing	3	0	0	3
6	ECE3405	Wavelets and Filter Banks	3	0	0	3
7	ECE3406	Probabilistic Systems analysis	3	0	0	3
8	ECE3407	Video Processing and Computer Vision	3	0	0	3
VLSI Design Basket						
1	ECE3455	VLSI Architecture	3	0	0	3
2	ECE3456	ASIC Design	3	0	0	3
3	ECE3457	Semiconductor Device Modeling	3	0	0	3
4	ECE3458	VLSI DSP Architectures	3	0	0	3

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
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	ECE3467	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	Vehicular Communication Systems	3	0	0	3
Wearable Technologies Basket						
1	ECE3431	Fundamentals of Wearable Sensing	3	0	0	3
2	ECE3432	Flexible Electronics and Sensors	3	0	0	3
3	ECE3433	Wearable Devices and Its Applications	3	0	0	3
4	ECE3434	Embedded Platforms for Wearables	3	0	0	3
5	ECE3435	Wireless Technologies for Wearables	3	0	0	3
6	ECE3436	Wearable Internet of Things	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

Table 3.7 : Discipline Elective Courses						
S. No.	Course Code	Course Name	L	T	P	C
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	-
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	-

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
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							
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	-

Sl. No.	Course Code	Course Name	L	T	P	C	Anti-requisites
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	-
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	MAT1211	Linear Algebra, Differential Equations and Statistical Methods	3	1	0	4	4	BSC	S	HP
2	CIV1200	Foundations of Integrated Engineering	2	0	0	2	2	ESC	S	
3	EEE1200	Basics of Electrical and Electronics Engineering	3	0	0	3	3	ESC	S	
4	EEE1251	Basics of Electrical and Electronics Engineering Lab	0	0	2	1	2	ESC	S/EM	
5	CHE2503	Applied Chemistry for Engineers	3	0	0	3	3	BSC	S	
6	CHE2504	Applied Chemistry for Engineers Lab	0	0	2	1	2	BSC	S	
7	CSS1500	Computational Thinking Using Python	2	0	2	3	4	ESC	S	
8	ENG1030	Fundamentals of Communication	1	0	2	2	3	HSMC	S	

9	PPS1025	Industry Readiness Program – I	0	0	2	0	2	MAC	EM	HP
		TOTAL				19	25	-	-	-

Semester 2 (Physics Cycle)										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE						TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS	BASKET		
1	MAT1213	Differential Equations, Complex Variables and Fourier Series	3	1	0	4	4	BSC	S	
2	MEC1006	Engineering Graphics	2	0	0	2	2	ESC	S	
3	PHY2502	Advanced Materials and Quantum Physics for Engineers	3	0	0	3	3	BSC	S	
4	PHY2505	Advanced Materials and Quantum Physics for Engineers Lab	0	0	2	1	2	BSC	S	
5	ECE2023	Digital Electronics	3	0	0	3	3	PCC	EM / EN	
6	ECE2051	Digital Electronics Lab	0	0	2	1	2	PCC	EM / EN	
7	ECE1512	Design Thinking in Practice	2	0	2	3	4	ESC	S/EM	
8	ENG2030	Communication in Practice	1	0	2	2	3	HSMC	S	
9	PPS1026	Industry Readiness Program – II	0	0	2	0	2	MAC	S	HP
		TOTAL				19	25			

Semester 3										
S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE						TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS	BASKET		
1	MAT2312	Transforms techniques and Vector Calculus for Communication Systems	3	1	0	4	4	BSC	S	
2	EEE2500	Network Theory	3	1	0	4	4	PCC	S	
3	ECE2508	Signal Processing	3	1	0	4	4	PCC	EM / EN	
4	ECE2558	Signals Processing Lab	0	0	2	1	2	PCC	EM	
5	ECE2517	Communication Systems	3	0	0	3	3	PCC	S/EM	
6	ECE2567	Communication Systems Lab	0	0	2	1	2	PCC	S / EM	HP
7	FIN1005	Finance Essentials for Decision Making	3	0	0	3	3	HSMC	S	
8	CSS2280	C Programming and Data Structures	3	0	0	3	3	ESC	S	

9	CSS2281	C Programming and Data Structures Lab	0	0	4	2	4	ESC	F/S	
10	CHE7601	Environmental Studies	-	-	-	0	0	MAC	S	ES
11	APT4002	Introduction to Aptitude	0	0	2	0	2	MAC	AT	
		TOTAL				25	31			

Semester 4

S. NO.	COURSE CODE	COURSE NAME	CREDIT STRUCTURE					BASKET	TYPE OF SKILL	COURSE ADDRESSES TO
			L	T	P	C	CONTACT HOURS			
1	MAT2322	Partial Differential Equations and Numerical Methods for Communication Systems	3	1	0	4	4	BSC	S	
2	ECE2509	Solid State Electronics	3	0	0	3	3	PCC	S / EM	HP
3	ECE2512	Microelectronics	3	0	0	3	3	PCC	S	
4	ECE2562	Microelectronics Lab	0	0	2	1	2	PCC	S	
5	ECE2536	Introduction to Fabrication Technology	3	0	0	3	3	PCC	S	
6	ECE2560	Introduction to Fabrication Technology Lab	0	0	2	1	2	PCC	EM	
7	EEE2504	Control Systems Engineering	3	0	0	3	3	PCC	EM	
8	ECE2521	Embedded Systems Design using Microcontrollers	4	0	0	4	4	PCC	S/EM/EN	
9	ECE2571	Embedded Systems Design using Microcontrollers Lab	0	0	2	1	2	PCC	S/EM	HP/GS
10	APT4004	Aptitude Training - Intermediate	0	0	2	0	2	MAC	AT	
11	CIV7601	Universal Human Values and Ethics	0	0	0	0	0	MAC	S	HP
		TOTAL				23	28			

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	S/ EM/ EN	ES
2	CSS2257	Computer Organization and Architecture	3	0	0	3	3	PCC	S/ EM/ EN	ES/ HP
3	ECE2522	CMOS VLSI Design	3	0	0	3	3	PCC	S	
4	ECE2572	CMOS VLSI Design Lab	0	0	2	1	2	PCC	S / EM / EN	ES / HP
5	CSS2264	Essentials of AI	3	0	0	3	3	ESC	F/S	
6	ECEXXXX	Professional Elective - I	3	0	0	3	3	PEC	S / EM	
7	ECEXXXX	Professional Elective - II	3	0	0	3	3	PEC	S / EM	
8	CSS2265	Essentials of AI Lab	0	0	2	1	2	ESC	S/EM	
9	APT4006	Logical and Critical Thinking	0	0	2	0	2	MAC	AT	

10	LAW7601	Indian Constitution	0	0	0	0	0	MAC	S	HP
		TOTAL				20	24			

Semester 6										
S. NO.	**COURSE CODE**	**COURSE NAME**	**CREDIT STRUCTURE**					**BASKET**	**TYPE OF SKILL**	**COURSE ADDRESSES TO**
			L	**T**	**P**	**C**	**CONTACT HOURS**			
1	ECE2515	Mixed Signal Circuit Design	3	0	0	3	3	PCC	S / EM / EN	ES / HP
2	ECE2523	Digital VLSI Design	3	0	0	3	3	PCC	S/ EM	HP
3	ECE2573	Digital VLSI Design Lab	0	0	2	1	2	PCC	S/ EM	HP
4	ECE2516	VLSI Design Verification	3	0	0	3	3	PCC	S / EM	ES
5	ECE2566	VLSI Design Verification Lab	0	0	2	1	3	PCC	S / EM	ES
6	ECEXXXX	Professional Elective - III	3	0	0	3	3	PEC	EM	
7	ECEXXXX	Professional Elective - IV	3	0	0	3	3	PEC	EM	
8	XXXXXXX	Open Elective - I	3	0	0	3	3	OEC	S/EM/EN	
9	APT4005	Aptitude for Employability	0	0	2	1	2	HSMC	AT	
10	ECE7100	Minor Project	-	-	-	4	-	PRW	SD / EM / EN	ES / HP
		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	S/ EM	HP
2	ECE2569	Physical Design and Automation Lab	0	0	2	1	3	PCC	S/ EM	HP
3	ECE2528	RF and HF IC Design	3	0	0	3	3	PCC	S/ EM	HP
4	ECEXXXX	Professional Elective - V	3	0	0	3	3	PEC	S/ EM	
5	ECEXXXX	Professional Elective - VI	3	0	0	3	3	PEC	S/ EM	
6	XXXXXXX	Open Elective - II	3	0	0	3	3	OEC	EM	
7	ECE7000	Internship	-	-	-	2	-	PRW	SD / EM / EN	ES / HP
8	PPS3018	Preparedness for Interview	0	0	2	1	2	HSMC	S	
		TOTAL				19	20			

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	SD / EM / EN	ES / HP
		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: **ENG1030**	**Course Title:** **Fundamentals of Communication** **Type of Course:** **Integrated**	**L-T-P-C**	1	0	2	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	Fundamentals of Communication is a lab intensive, practice first integrated course designed to introduce first-year undergraduate engineering and computer science students to the foundational principles and advanced applications of effective communication across interpersonal, spoken, written, and digital contexts. Anchored in real world scenarios directly relevant to college life, cross-functional technical teams, and digital workplaces, the curriculum develops students' abilities to navigate cultural differences, speak with clarity, read texts critically, and write with precise audience awareness. The course explicitly relies on scenario-based learning, interactive case studies, and hands-on lab applications to ensure that theoretical communication frameworks are immediately actionable. By guiding students from reflective self-awareness to complex digital and AI-mediated content creation, the course builds an enduring communicative foundation optimized for performance-oriented professional practice.					
Course Objective	The course aims to explain the key principles of interpersonal, intercultural, and professional communication and apply them to real-world scenarios. It also focuses on developing spoken communication strategies, including structured delivery and impromptu responses, for academic and group contexts. Furthermore, it aims to develop effective writing skills to produce clear, coherent, and audience-appropriate texts across formal and professional contexts.					
Course Outcomes	**On successful completion of this course the students shall be able to:** **CO1. Understand** the principles of interpersonal, intercultural, and professional communication in academic, social, and technical team contexts.					

<table>
<tr><td></td><td colspan="4">CO2. Demonstrate audience-centered spoken communication in individual presentations, group discussions, and simulated professional scenarios through vocal control, adaptive register, and collaborative engagement.
CO3. Interpret written, multimodal, and AI-generated texts to identify underlying assumptions, rhetorical strategies, logical errors, and credibility markers across diverse media and professional contexts.
CO4. Utilize plain-language principles and professional conventions to produce clear, purposeful, and appropriately formatted written and multimodal communication, including technical content adapted for non-specialist audiences.
CO5. Employ responsible and critical practices in AI-assisted communication by designing iterative prompts, evaluating generated outputs, and applying ethical frameworks in academic and professional contexts.</td></tr>
<tr><td colspan="5">Course Content: Fundamentals of Communication</td></tr>
<tr><td>Module 1</td><td>Communication in a New World</td><td>CA1 + Project Milestone</td><td>Deep Listening and Contextual Response Lab</td><td>06 Sessions</td></tr>
<tr><td colspan="5">The topics will be discussed through case studies:
• The Communication Process: How Messages Are Sent, Received, and Misread
• Verbal, Non-Verbal, and Vocal Communication in Everyday Contexts
• Communication Breakdown: Recognising Barriers Across Psychological, Cultural, and Semantic Dimensions
• Active Listening: Attention, Paraphrasing, and Purposeful Response; asking for clarification
• Interpersonal Communication and Self-Awareness (including cross-cultural dimensions)</td></tr>
<tr><td>Module 2</td><td>Contemporary Speaking Practices</td><td>CA2, CA3, CA4</td><td>Narrative and Adaptive Oral Delivery
Facilitated Stakeholder Group Discussion
Simulated Workplace Crisis Briefing</td><td>15 Sessions</td></tr>
<tr><td colspan="5">The topics will be discussed through structured, individual presentations and group discussions:
• Elements of Spoken Communication: Voice, Clarity, and Presence
• Storytelling and Narrative in Spoken Contexts
• Structuring Spoken Messages: From Idea to Delivery
• Speaking with Confidence: Managing Anxiety and Building Presence
• Communicating in Groups: Participation, Productive Disagreement, and Turn-Taking
• Giving and Receiving Feedback Effectively
• Presentation Design and Delivery: Structure, Evidence, and Audience Engagement; eliciting responses
• Speaking for Technical and Non-Technical Audiences</td></tr>
<tr><td>Module 3</td><td>Critical Reading</td><td>Project Milestone</td><td>Source Audit and Fallacy Brief</td><td>09 Sessions</td></tr>
</table>

The topics will be discussed through case studies and real-world scenarios:

- Critical Reading: Purpose, Context, and Analytical Approach
- Perspective and Persuasion: Identifying Tone, Bias, and the Fact-Opinion Distinction
- Understanding Flawed Reasoning *(patterns of weak argumentation in everyday contexts)*
- Evaluating Sources: Credibility, Reliability, and AI-Generated Content; accuracy of the content
- Reading Multimodal Texts: Images, Infographics, and Digital Media

Module 4	**Writing with Purpose**	**CA 5 + Project Milestone**	**Technical Translation and Annotated Script**	**09 Sessions**

The topics will be discussed through case studies:

- Principles of Effective Writing: Clarity, Coherence, Precision and Concise; audience analysis
- Plain Language and Technical Communication: Making Complex Ideas Accessible
- Writing for Professional Contexts: Email, Formal Reports, and Correspondence
- Argumentative Writing: Claim, Evidence, and Logical Progression
- Summary Writing and Short-Form Academic Response

Module 5	**Communication in the Age of AI**	**CA 6 – Project Milestone**	**CA 6: Cross-Disciplinary Case Analysis and Defence**	**06 Sessions**

The topics will be discussed through case studies featuring real-world examples:

- AI as a Communication Tool: Capabilities, Limitations, and the Hallucination Problem
- Prompt Engineering: Communicating Effectively with AI Systems
- AI-Assisted Writing: Drafting, Refining, and Maintaining Your Voice
- Ethical and Legal Dimensions of AI in Communication *(includes India's Digital Personal Data Protection Act, 2023)*
- AI, Bias, and Critical Evaluation: Reading AI Outputs Responsibly

Targeted Application & Tools that can be used: Otter.ai, Microsoft Word/PowerPoint/Teams/Clipchamp/Whiteboard/OneNote/Forms/Copilot, Miro, Padlet, Canva, Mentimeter, AllSides Media Bias Ratings, Ad Fontes Media Bias Chart, Snopes/factcheck.rog, Zotero, NotebookLM, Canva, Adobe Express, CapCut, OBS Studio, Claude, ChatGPT, Gemini, DeepSeek, Google Docs

Project Work / Assignment:

1. **Multimodal Communication Portfolio** (Project) with multiple milestones: Continuous, milestone based. Developed across all five modules. Final consolidated submission at the end of the course. Develop a progressive, publicly shareable communication portfolio that demonstrates the student's ability to move a technical concept across multiple audiences, formats, and media.
2. **Active Listening and Contextual Response Lab** (Individual): Students listen to an unedited, multi-speaker audio recording of a real or simulated professional scenario. Under timed conditions, students produce a structured written brief consisting of four parts. Assessed on comprehension accuracy, analytical precision, quality of questioning, and practicality of the proposed strategy.

3. **Narrative and Adaptive Oral Delivery** (Individual): Each student delivers a 4-minute structured presentation. At the 3-minute mark, the faculty assessor introduces a counter-perspective or an unexpected constraint, and the student must adapt their argument in real time for the remaining minute. The assessment evaluates: the quality of the prepared 3 minutes; the quality of the improvised adaptation; and the degree to which the full 4 minutes function as a coherent whole.
4. **Facilitated Stakeholder Group Discussion** (Group): Groups of 5–6 students are each assigned a distinct stakeholder position within a shared scenario. and must engage in a live, facilitated discussion to resolve a stated policy impasse. No prepared scripts are permitted; students receive their role brief 15 minutes before the discussion begins. Assessment is individual, not group-level.
5. **Simulated Workplace Crisis Briefing** (Group)**:** Groups of 4–5 students receive an unexpected corporate or institutional emergency brief. Teams have exactly 30 minutes to read the brief, distil the critical information, assign speaking roles, and prepare a 5-minute status update for a simulated leadership panel.
6. **Technical Translation and Annotated Script** (Individual)**:** Students receive a dense, jargon-heavy technical document. Students must: (a) read and fully comprehend the document; (b) identify the core idea that a non-specialist audience needs to understand; and (c) produce an annotated script for a 90-second public explainer.
7. **Cross-Disciplinary Case Analysis and Defence** (Group)**:** Groups of 3–4 students select one case from a faculty-curated shortlist of five to six approved cases. The group delivers a 10-minute structured presentation that goes beyond narrative description - identify the specific communication failures, explain the ethical or regulatory dimensions of those failures, and propose what a communication-competent response would have looked like. This is followed immediately by a 5-minute live Q&A in which individual group members must defend their analytical assertions against probing questions from both faculty and peers.

Text Book(s):

1. Markel, M., & Selber, S. A. (2021). *Technical Communication* (13th ed.). Bedford/St. Martin's.

Reference Book(s):

R1. Carnegie, D. (1936/1998). *How to Win Friends and Influence People*. Simon & Schuster.

R2. Orwell, G. (1946). *Politics and the English Language*.

R3. Strunk, W., & White, E. B. (1999). *The Elements of Style* (4th ed.). Longman.

R4. Kahneman, D. (2011). *Thinking, Fast and Slow*. Farrar, Straus and Giroux.

R5. O'Neil, C. (2016). *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown Publishers.

R6. Adler, R. B., Rodman, G., & DuPré, A. (2019). *Understanding Human Communication* (14th ed.). Oxford University Press.

Web Sources:

- owl.purdue.edu
- plainlanguage.gov
- allsides.com
- adfontesmedia.com

• ted.com • economist.com/styleguide • factcheck.org • ailiteracy.org • learnprompting.org • unesco.org/en/artificial-intelligence/ethics	
Topics relevant to "SKILL DEVELOPMENT": Active listening, verbal and non-verbal communication, interpersonal communication and self-awareness, elements of spoken communication — voice, clarity, and presence, storytelling and narrative in spoken contexts, structuring spoken messages, speaking with confidence, group communication and productive disagreement, giving and receiving feedback, presentation design and delivery, speaking for technical and non-technical audiences, critical reading, identifying tone and bias, understanding flawed reasoning, source credibility and information evaluation, reading multimodal texts, principles of effective writing, plain language and technical communication, professional writing — email, reports, and correspondence, argumentative writing, summary writing, prompt engineering, AI-assisted writing, ethical AI use in academic and professional communication, AI bias and critical evaluation.	
Catalogue prepared by	Dr Ajith K and Dr Shahanas Punnilath Shanavas
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: **ENG2030**	**Course Title:** **Communication in Practice** **Type of Course:** **Integrated**	**L-T-P-C**	1	0	2	2
Version No.	1.0					
Course Pre-requisites	ENG1030– Fundamentals of Communication (Semester I)					
Anti-requisites	NIL					
Course Description	*Communication in Practice* is the second-semester course in sequence designed for first-year undergraduate students in engineering and computer science programmes. This course puts those foundations under professional pressure. The question is no longer *what* communication is, but *how* to deploy it when it counts: in a job interview, a pitch to a client, a negotiation with a colleague, a professional report directed at a real reader, or a leadership communication					

<table>
<tr><td></td><td>challenge that affects a team. The course is organised around four modules, each of which explicitly upgrades the work done in semester one. Assessment is 100% Continuous Assessment. There is no end-semester examination. The centrepiece is a capstone Professional Communication Portfolio that the student could realistically share with an employer.</td></tr>
<tr><td>Course Objective</td><td>The course aims to articulate the foundational tenets of professional communicative identity, discourse ethics, and analytical text evaluation and apply them to high-stakes institutional scenarios and complex professional ecosystems. It also focuses on cultivating advanced oral communication strategies and persuasive vocal mechanics, including structured rhetorical delivery and spontaneous adaptive responses, for collaborative, hierarchical, and leadership contexts. Furthermore, it aims to refine technical authorship capabilities and artificial intelligence-mediated workflows to produce precise, highly structured, and audience-centric professional artifacts across formal engineering, computational, and cross-functional corporate domains.</td></tr>
<tr><td>Course Outcomes</td><td>On successful completion of this course the students shall be able to:
1. Explain the principles governing professional communication identity, communicator ethics, and context-sensitive self-presentation across workplace, hierarchical, and digital contexts.
2. Demonstrate advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches, negotiations, and leadership scenarios.
3. Demonstrate advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches, negotiations, and leadership scenarios.
4. Execute the production of professional-grade written artifacts across high-demand genres—including formal reports, business proposals, data communications, and advocacy briefs—meeting real-world standards of clarity, structure, and audience appropriateness.
5. Implement AI-assisted communication workflows in professional contexts, including systematic prompt design for high-stakes outputs, validation protocols for synthetic materials, and the application of ethical frameworks at individual and organizational levels.</td></tr>
</table>

Course Content: Communication in Practice

Module 1	Words that Work: Vocabulary, Register, and Precision	CA1	Register Switching Activity	09 Sessions

The topics will be explored through vocabulary games, role-play activities, communication challenges, case-based tasks, and workplace simulations:

- Why Words Matter in Professional and Technical Communication
- Choosing the Right Words for Different Situations
- Understanding Meaning: Positive, Negative, and Neutral Word Choices
- Commonly Confused Words and Miscommunication in Professional Contexts
- Using Clear, Precise, and Concise Language
- Explaining Technical Terms to Non-Technical Audiences
- Building and Using Personal/Professional Vocabulary

<table>
<tr><td>Module 2</td><td>Listening, Processing, and Structured Response Writing</td><td>CA2</td><td>Rapid Listening and Response</td><td>12 Sessions</td></tr>
<tr><td colspan="5">The topics will be explored through podcasts, interviews, workplace recordings, collaborative listening tasks, discussions, and real-time writing activities:

• Identifying Key Information from Spoken Inputs
• Organizing Information from Discussions and Conversations
• Converting Spoken Communication into Clear and Structured Written Responses
• Writing Summaries from Audio and Discussion Inputs
• Writing Follow-Up Responses Based on Spoken Communication
• Writing Action Notes, Instructions, and Task Updates from Listening Inputs
• Converting Meetings and Discussions into Structured Written Outputs</td></tr>
<tr><td>Module 3</td><td>High-Stakes Spoken Communication</td><td>CA</td><td>Mock Professional Interview, Pitching an Idea Pitch</td><td>12 Sessions</td></tr>
<tr><td colspan="5">• Speaking as a professional: identity, presence, and the first impression
• Vocal authority, physical presence, and communication across hierarchies
• Interview communication: structure, composure, and the STAR framework
• Pitching ideas: the 3-minute and 10-minute pitch architecture
• Negotiation and principled disagreement
• Communicating in leadership positions: chairing, facilitating, and giving direction
• Managing communication under pressure: hostile questions, silence, and contradiction</td></tr>
<tr><td>Module 4</td><td>Adaptive Communication</td><td>CA</td><td>Communication Strategy Plan</td><td>12 Sessions</td></tr>
<tr><td colspan="5">The topics will be explored through leadership simulations, AI-assisted scenario practice, ethical debate exercises, case analysis, peer feedback sessions, and reflective portfolio activities:

• Communication Strategy: Audiences, Channels, Timing, and Feedback Loops
• What Emotional Intelligence Actually Does in High-Stakes Conversations
• Reading the Room: Adapting Style Across Personalities, Contexts, and Power Gaps
• Giving and Receiving Developmental Feedback as a Professional Practice
• Navigating Difficult Conversations: Disagreement, Criticism, and Bad News
• Repairing Communication Breakdowns: Apology, Accountability, and Recovery
• AI as a Strategic Communication Tool: Capabilities, Limits, and What Professionals Must Decide</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used: Otter.ai, Microsoft Word/PowerPoint/Teams/Clipchamp/Whiteboard/OneNote/Forms/Copilot, Miro, Padlet, Canva, Mentimeter, AllSides Media Bias Ratings, Ad Fontes Media Bias Chart, Snopes/factcheck.rog, Zotero, NotebookLM, Canva, Adobe Express, CapCut, OBS Studio, Claude, ChatGPT, Gemini, DeepSeek, Google Docs</td></tr>
<tr><td colspan="5">Project Work / Assignment:</td></tr>
</table>

1. Register Switching Activity (Individual): Students receive a single professional scenario and must communicate the same core message to three different audiences — a peer, a manager, and a non-specialist outsider — switching register, vocabulary, and tone appropriately for each. Delivered live in class. Graded on accuracy of register shift, vocabulary choices, and adaptability under in-the-moment feedback from the assessor.

2. Word in the Wild Log (Individual): Over four weeks, students maintain a running log of 25 words or phrases encountered in professional contexts — podcasts, workplace conversations, news, interviews — that they did not fully understand or could not have used confidently themselves. For each entry, students record the source, the meaning in context, an alternative they might have used, and one original sentence demonstrating precise use. Submitted as a structured document at the end of Module 1. Graded on range, contextual accuracy, and quality of reflection.

3. Rapid Listening and Response (Individual): Students listen to an unedited workplace audio recording — a meeting excerpt, a briefing, or a professional conversation — played once, without transcripts. Under timed conditions, they produce a structured written response that captures key information, identifies the communication purpose, and drafts an appropriate follow-up action note. Graded on accuracy, organisation, and quality of written response.

4. Mock Professional Interview (Individual): Each student undergoes a 10-minute mock professional interview conducted by faculty or a peer panel. No prepared scripts permitted. Graded on composure, structure, vocal authority, and use of the STAR framework. Written self-evaluation of 200 words submitted within 48 hours.

5. Idea Pitch (Individual): Students deliver a 3-minute pitch of a solution to a real or simulated professional problem, to a panel that includes at least one hostile or sceptical questioner. Immediately after the pitch, the panel asks two minutes of unscripted questions. Graded on clarity of argument, persuasive structure, handling of pressure, and vocal presence.

6. Difficult Conversation Simulation (Pair): Pairs of students are assigned roles in a scripted conflict scenario — a performance issue, a missed deadline, a broken professional agreement. Each student must navigate the conversation toward a constructive resolution without a script. Immediately after, both students complete a structured individual debrief identifying what communication choices they made, what they would change, and what they observed in their partner. Graded individually on communication behaviour during the simulation and quality of the debrief.

7. Communication Strategy Plan — Presentation and Portfolio Submission (Group): Students select a real or realistic professional scenario — a team conflict, a stakeholder disagreement, a leadership announcement, or a crisis communication moment. They develop a communication strategy plan that maps the audience, chooses appropriate channels and timing, anticipates likely responses, and identifies where AI tools could assist and where they must not. The plan is delivered as a 5-minute structured presentation to a simulated panel, followed by two minutes of unscripted Q&A. The portfolio submission includes the written plan, a one-page reflection on their communication growth across all four modules, and one piece of evidence from each module that demonstrates that growth. Graded on strategic thinking, clarity of presentation, quality of reflection, and coherence of the portfolio as a whole.

Text Book(s):

T1. Treasure, J. (2017). *How to be Heard: Secrets for Powerful Speaking and Listening.* Mango Publishing.

T2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2019). *Communication: Principles for a Lifetime* (7th ed.). Pearson.	
Reference Book(s):	
R1. Goleman, D. (1995). *Emotional Intelligence: Why It Can Matter More Than IQ.* Bantam Books. R2. Patterson, K., Grenny, J., McMillan, R., & Switzler, A. (2011). *Crucial Conversations: Tools for Talking When Stakes Are High* (2nd ed.). McGraw-Hill. R3. Cuddy, A. (2015). *Presence: Bringing Your Boldest Self to Your Biggest Challenges.* Little, Brown and Company. R4. Fisher, R., Ury, W., & Patton, B. (2011). *Getting to Yes: Negotiating Agreement Without Giving In* (3rd ed.). Penguin Books. R5. Stone, D., Patton, B., & Heen, S. (2010). *Difficult Conversations: How to Discuss What Matters Most* (2nd ed.). Penguin Books.	
Web Sources:	
• ted.com/topics/communication • ted.com/topics/leadership • hbr.org (Harvard Business Review — communication and leadership articles) • psychologytoday.com/us/basics/emotional-intelligence • learnprompting.org • unesco.org/en/artificial-intelligence/ethics • yoodli.ai (AI speech coaching) • themuse.com (professional communication and career resources) • mindtools.com (communication skills and workplace tools)	
Topics relevant to "SKILL DEVELOPMENT": Vocabulary building and register awareness; precise and concise language use; explaining technical terms to non-specialist audiences; active listening and information processing; converting spoken inputs into structured written responses; writing action notes and follow-up communications; professional presence and vocal authority; interview communication and the STAR framework; idea pitching and persuasive speaking; negotiation and principled disagreement; chairing and facilitating discussions; managing communication under pressure; communication strategy and audience mapping; emotional intelligence in professional contexts; adapting communication style across personalities and power gaps; giving and receiving developmental feedback; navigating difficult conversations; repairing communication breakdowns; AI as a strategic communication tool; ethics of AI in professional communication.	
Catalogue prepared by	Dr Ajith K and Dr Shahanas Punnilath Shanavas
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 "Preparing for Interview" and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.					
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 of 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.				

<table>
<tr><td>Course Objective</td><td colspan="6">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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.</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td>Module 1</td><td>Quantitative Ability</td><td>Lab-10hrs</td><td></td><td>Platform Assessment-10hrs</td><td>20 Hours</td></tr>
<tr><td></td><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Verbal Ability</td><td>Lab-5hrs</td><td></td><td>Platform Assessment-5hrs</td><td>10 Hours</td></tr>
<tr><td></td><td colspan="5">Topics: - Parts of Speech, Subject Verb Agreement, Spotting Error, Cloze Test, Verbal Analogies,
Reading Comprehension, Idioms & Phrases, Para Jumbles</td></tr>
<tr><td></td><td colspan="5">Targeted Application & Tools that can be used:
Application area: Placement activities and Competitive examinations. Tools: LMS</td></tr>
<tr><td>Evaluation</td><td colspan="5">Continuous Evaluation
• Topic wise evaluation</td></tr>
<tr><td></td><td colspan="5">Text Book
1. Fast track objective by Rajesh Verma
2. R S Aggarwal
3. S.P Bakshi</td></tr>
<tr><td colspan="6">References
1. www.indiabix.com
2. www.testbook.com
3. www.youtube.com/c/TheAptitudeGuy/videos</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>Catalogue prepared by</td><td colspan="5">Faculty of L&D</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td colspan="5"></td></tr>
</table>

Date of Approval by the Academic Council	

BSC Basket

<table>
<tr><td>Course Code:
MAT1211</td><td>Course Title: Linear Algebra, Differential Equations and Statistical Methods
Type of Course:1] School Core</td><td>L-T- P- C</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">This course introduces fundamental mathematical concepts from linear algebra, differential calculus, ordinary differential equations and statistics. The content includes matrices, systems of linear equations, eigenvalues and eigenvectors, functions of several variables, differential equations, correlation and regression analysis, and curve fitting techniques. The course combines theoretical developments with illustrative applications drawn from scientific and engineering settings. The course emphasizes the application of these mathematical tools in solving problems in science and engineering. It extends student's problem-solving abilities through analytical and computational approaches, with focus on both theoretical understanding and applications.</td></tr>
<tr><td>Course Objective</td><td colspan="6">The objective of this course is to provide students with a strong mathematical foundation required for engineering and scientific studies. The course introduces fundamental concepts from linear algebra, differential calculus, ordinary differential equations, and statistical methods that are widely used in modeling, analysis and problem solving. It aims to familiarize students with mathematical techniques for representing engineering systems, studying relationships among variables, describing dynamic processes and interpreting data. The course serves as a foundation to prepare students for advanced engineering subjects that rely on mathematical modeling, computation and analytical methods.</td></tr>
<tr><td>Course Out Comes</td><td colspan="6">On successful completion of the course the students shall be able to:
CO1: Use linear algebra concepts to evaluate properties of matrices and quadratic forms. (L3)
CO2: Apply matrix-based methods to solve systems of linear equations. (L3)
CO3: Use fundamental theorems and analytical techniques of differential calculus to single variable functions. (L3)
CO4: Apply the concepts of partial derivatives to multivariable functions. (L3)
CO5: Solve first order ordinary differential equations using analytical methods. (L3)
CO6: Employ statistical techniques for data analysis and to interpret relationships between variables. (L3)</td></tr>
<tr><td colspan="7">Course Content:</td></tr>
<tr><td>Module 1</td><td colspan="2">Fundamentals of Linear Algebra</td><td colspan="4">(15L+5T=20 Sessions)</td></tr>
<tr><td colspan="7">Matrices, echelon forms, rank of matrix, Systems of linear equations: Consistency, solution to system of linear homogeneous and non-homogeneous equations- Gauss elimination method, Gauss-Jordan method (Self-study), LU decomposition method, Network analysis using linear systems, Design of traffic patterns, Electrical circuits.
Eigenvalue and eigenvector, diagonalization of symmetric matrices, quadratic forms.</td></tr>
<tr><td>Module 2</td><td colspan="2">Differential Calculus</td><td colspan="4">(15L+5T=20 Sessions)</td></tr>
</table>

Introduction, limit, continuity, Rolle's theorem, mean value theorems, Indeterminate forms and L'Hôpital's rule.
Partial derivatives, Euler's theorem, total derivative, Jacobians, Taylor's and Maclaurin's theorems, maxima, minima and saddle points, method of Lagrange multipliers, Current Growth in an RL Circuit, Velocity Estimation, Fuel consumption optimization, Cost function optimization.

Module 3	**Ordinary Differential Equations**	**(6L+2T=8 Sessions)**

Definition, types of differential equations-variable separable, homogeneous, exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Newton's law of cooling, Current in RL circuit.

Module 4	**Statistical Methods and Curve Fitting**	**(9L+3T=12 Sessions)**

Measures of central tendency, moments, skewness, and kurtosis. Correlation - Karl Pearson's coefficient of correlation, rank correlation, multiple correlation. Regression analysis - lines of regression, multiple regression. Principle of least square, curve fitting- straight line, parabola and exponential curves, Stress and strain curve fitting, Feature selection and Prediction models.

Targeted Applications & Tools that can be used:

- Linear Algebra is applied to solve systems of equations in circuits, traffic flow, and network analysis, with eigenvalues and quadratic forms aiding stability and optimization studies.
- Differential Calculus supports process speed analysis, velocity estimation, and optimization techniques such as minimizing fuel consumption and cost functions.
- Differential Equations model dynamic behaviours like current in RL circuits, heat transfer in materials, and growth or decay in environmental and nuclear engineering.
- Statistical Methods and Curve Fitting enable effective data analysis through correlation, regression, and curve fitting, supporting predictive modeling and interpretation of experimental data such as stress-strain relationships.

Software: MATLAB, Python, R Programming, Mathematica, Scilab, Octave

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. B. S. Grewal, *Higher Engineering Mathematics*, 44th ed. New Delhi, India: Khanna Publishers, 2017.
2. D. C. Montgomery and G. C. Runger, *Applied Statistics and Probability for Engineers*, 7th ed. Hoboken, NJ, USA: Wiley, 2018.

References:

1. P. V. O'Neil, *Advanced Engineering Mathematics*, 8th ed. Boston, MA, USA: Cengage Learning, 2018.
2. R. I. Miller and J. E. Freund, *Probability and Statistics for Engineers*, 9th ed. Noida, India: Pearson Education Ltd., 2017.
3. E. Kreyszig, *Advanced Engineering Mathematics*, 10th ed. Hoboken, NJ, USA: John Wiley & Sons, 2011.
4. V. Henner, T. Belozerova, and M. Khenner, *Ordinary and Partial Differential Equations*. Boca Raton, FL, USA: CRC Press, 2013.

E-resources/ Web links:

1. https://nptel.ac.in/courses/111105121
2. https://nptel.ac.in/courses/111106146
3. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_106839
4. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_61605
5. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_134719

6. https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=TEXTBOOK_LIBRARY01_06082022_174	
Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of differential calculus, differential equations and statistical methods 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. Kavita Permi, Dr. Rahul M. P. and Dr. Athmakoori Prashant**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: **MAT1213**	**Course Title: Differential Equations, Complex Variables and Fourier Series** **Type of Course:1] School Core**	**L-T- P- C**	**3**	**1**	**0**	**4**
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive study of advanced mathematical methods essential for engineering, scientific, and applied mathematical analysis. It covers techniques of integral calculus, including reduction formulae, Beta and Gamma functions, and their applications; methods for solving second and higher-order ordinary differential equations; fundamental concepts of complex analysis such as analytic functions, conformal mappings, complex integration, and residue theory; and Fourier series representations of periodic functions. The course emphasizes both theoretical understanding and practical problem-solving skills, enabling students to apply mathematical techniques to model, analyze, and solve real-world problems in engineering and science.					
Course Objective	The main objective of the course is that students should develop skills in advanced integration techniques and special functions. It teaches students how to solve higher-order ordinary differential equations. Students can think logically and apply the theoretical knowledge of Fourier series to analyze periodic phenomena. It will enhance knowledge mathematical modeling and problem-solving abilities.					
Course Outcomes	On successful completion of the course the students shall be able to: **CO1:** Apply advanced integration techniques to solve mathematical problems. (L3) **CO2:** Solve linear ordinary differential equations of higher order. (L3) **CO3:** Apply the principles of analyticity and harmonicity to solve problems involving complex functions. (L3) **CO4:** Evaluate contour integrals using residue theory. (L3) **CO5:** Represent functions through Fourier series and half-range expansions. (L3) **CO6:** Use mathematical tools in engineering and scientific applications. (L3)					
Course Content:						
Module 1	**Integral Calculus**	**(13L+4T=17 Sessions)**				
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Double integrals (Cartesian), Change of order of integration in double integrals, Triple integrals, Change of variables (Cartesian to polar, cylindrical and spherical coordinates), areas, volume -Center						

of mass and Gravity (constant and variable densities), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds, application problems.

Module 2	**ODE - Second and Higher Order**	**(8L+3T=11 Sessions)**
Linear differential equations of second and higher order with constant coefficients - non-homogeneous term of the type $Q(x) = e^{ax}$, $Sin\, ax$, $Cosax$, $e^{ax}v(x)$, $x^n v(x)$ - Method of variation of parameters, Analysis of RLC Circuits Using Second-Order Differential Equations, Voltage and Current Response in Electrical Networks.		
Module 3	**Complex Analysis**	**(15L+5T=20 Sessions)**
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), Transmission Line Modelling, Residue-Based Circuit Analysis.		
Module 4	**Fourier Series**	**(9L+3T=12 Sessions)**
Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2p and arbitrary period. Half range Fourier series. Practical harmonic analysis, Representation of a Square Wave Using Fourier Series.		

Targeted Applications & Tools that can be used:

- Computation of areas, volumes, center of mass, and moments in engineering systems; evaluation of multiple integrals in fluid flow, heat transfer, electromagnetics, and 3D geometric modeling.
- Modeling and analysis of dynamic systems, RLC circuits, electrical networks, mechanical vibrations, control systems, and transient response analysis.
- Analysis of transmission lines, electrical circuits, signal processing systems, fluid flow problems, conformal mapping applications, and residue-based engineering computations.
- Harmonic analysis, signal decomposition, communication systems, waveform representation, vibration analysis, image processing, and frequency-domain analysis.

Software: MATLAB, Mathematica, Maple, Python, GeoGebra, Octave, R, Scilab, COMSOL Multiphysics, Wolfram Alpha.

Assignment:

Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor.

Text Book

1. N. P. Bali and M. Goyal, *A Textbook of Engineering Mathematics*, 10th ed. New Delhi, India: Laxmi Publications, 2019.
2. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 9th ed. New York, NY, USA: McGraw-Hill Education, 2014
3. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, 5th ed. New Delhi, India: Narosa Publishing House, 2016.

References:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 11th Indian Adaptation ed. New Delhi, India: Wiley India, 2025.
2. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 9th ed. New York, NY, USA: McGraw-Hill Education, 2014.
3. D. G. Zill, *A First Course in Differential Equations with Modeling Applications*, 12th ed. Boston, MA, USA: Cengage Learning, 2024.
4. M. R. Spiegel, *Schaum's Outline of Advanced Mathematics for Engineers and Scientists*, 1st ed. New York, NY, USA: McGraw-Hill Education, 2013.

E-resources/ Web links:

1. https://research.ebsco.com/c/n5guci/search/details/6wtbgoqnff?request-context=plink&db=nlebk
2. https://research.ebsco.com/c/n5guci/search/details/grd6xqd7pv?db=nlebk&limiters=None&q=Fourier%20series&searchMode=boolean

3. https://research.ebsco.com/c/n5guci/search/details/qcdqrufxg5?request-context=plink&db=nlebk	
Topics relevant to SKILL DEVELOPMENT: This course fosters critical analytical and computational skills by training students to formulate and solve complex higher-order ordinary differential equations that model real-world physical systems. Additionally, analyzing complex analytic functions and synthesizing Fourier series equips the technical proficiency to interpret signal behaviors, harmonic waveforms, and boundary value problems in engineering domains.	
Catalogue prepared by	**Dr. Heena Firdose**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: MAT2312	**Course Title: Transform Techniques and Vector Calculus for Communication Systems** **Type of Course:1] School Core**	**L-T- P- C**	**3**	**1**	**0**	**4**
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces fundamental mathematical tools used in engineering, physics, and applied sciences. The course covers Fourier, Laplace, and Z-transforms for solving differential and difference equations arising in physical systems and signal processing. It also develops the concepts of vector calculus, including gradient, divergence, curl, line and surface integrals, and major integral theorems. Emphasis is placed on problem-solving and applications in engineering and scientific modeling.					
Course Objective	This course is designed to develop a strong foundation in integral transforms and vector calculus and to enhance analytical and problem-solving skills for engineering applications. It equips students with the ability to apply Laplace, Fourier, and Z-transform techniques to solve differential equations, difference equations, and system-related problems arising in continuous and discrete domains. The course also introduces the analysis of scalar and vector fields through gradient, divergence, curl, and vector integration, along with the application of Green's, Gauss's, and Stokes' theorems. Emphasis is placed on mathematical modelling and applications in signal processing, control systems, electrical circuits, communication systems, fluid flow, electromagnetics, and scientific computing.					
Course Out Comes	After successful completion of the course, students will be able to: **CO1:** Apply transformation methods to solve piecewise-defined mathematical models. (L3) **CO2:** Employ Laplace transform techniques to solve ordinary differential equations arising in Engineering problem. (L3) **CO3:** Apply Fourier transform methods to solve problems related to signals and systems. (L3) **CO4:** Apply Z-transform and inverse Z-transform techniques to solve difference equations and discrete-time system problems. (L3) **CO5:** Apply vector differential operators to analyze scalar and vector fields and identify solenoidal and irrotational fields. (L3) **CO6:** Apply vector integration techniques and integral theorems to a solve engineering problems. (L3)					
Course Content:						

Module 1	**Laplace Transform**	**(12L + 4T = 16 Sessions)**
Laplace transforms elementary functions. Properties of Laplace transform, 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 Transform**	**(9L + 3T = 12 Sessions)**
Infinite Fourier transforms, Fourier sine and cosine transforms, Properties, Convolution, Inverse Fourier transforms, Problems. Application to Ordinary Differential Equations		
Module 3	**Z-Transform**	**(9L + 3T = 12 Sessions)**
Z-transforms, Standard Z-transforms, Linearity property, Damping rule, Shifting rule, Initial value theorem, Final value theorem, Inverse Z-transforms. Application to difference equations.		
Module 4	**Vector Calculus**	**(15L + 5T = 20 Sessions)**
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 Applications & Mathematical Tools:

- Modeling and solving differential equations in electrical circuits, control systems, and dynamic engineering systems.
- Signal analysis, frequency-domain processing, communication systems, image and audio processing.
- Analysis of discrete-time systems, digital signal processing, and difference equation modeling.
- Analysis of fluid flow, electromagnetic fields, heat transfer, and engineering field problems.

Software: MATLAB, Python, Mathematica, Maple, Scilab, GNU Octave, MS Excel.

Assignment:

Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor.

Text Book

3. B. S. Grewal, *Higher Engineering Mathematics*, 44th Edition, Khanna Publishers, 2017.
4. E. Kreysig, *Advanced Engineering Mathematics*, 10th edition, Wiley Publication, 2011.

References:

5. Peter V. O'Neil, *Advanced Engineering Mathematics*, 7th Edition, Cengage Learning, 2012.
6. C. Ray Wylie and Louis C Barrett, *Advanced Engineering Mathematics*, 6th Edition, McGraw-Hill, 2012.
7. Glyn James & Phil Dyke, *Advanced Modern Engineering*, 5th Edition, Pearson Education Limited, 2018.

E-resources/ Web links:

1. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=VTU_CONSORTIA_DATA_14112024_23450
2. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=CUSTOM_PACKAGE_EBSCO_29052023_53751
3. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=CUSTOM_PACKAGE_EBSCO_29052023_228712
4. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=EBSCO95_10122025_145338
5. NPTEL Laplace Transform https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ma54
6. NPTEL Fourier Transform https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ma22
7. NPTEL Vector Calculus: https://nptel.ac.in/courses/111/105/111105122/
8. https://www.math.hkust.edu.hk/~maqian/ma006_0607F.html
9. https://www.scu.edu.au/study/units/math2002/2026/

Topics relevant to SKILL DEVELOPMENT: The course focuses on the concepts of Fourier Series, Fourier Transforms, Z-Transforms and Vector calculus 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 Rajeshwari M**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: **MAT2322**	**Course Title: Partial Differential Equations and Numerical Methods for Communication Systems** **Type of Course:1] School Core**	**L-T- P- C**	**3**	**1**	**0**	**4**
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course introduces fundamental and advanced numerical techniques for solving algebraic, transcendental, and differential equations. Students will learn direct and iterative methods for linear systems, root-finding algorithms, interpolation, numerical differentiation and integration, and numerical solutions of ordinary and partial differential equations. Emphasis is placed on both theoretical foundations and practical applications in engineering and applied sciences, with attention to accuracy, stability, and convergence of methods.					
Course Objective	The objective of this course is to equip students with a solid foundation in numerical methods and their applications to algebraic, transcendental, and differential equations. It aims to develop an understanding of direct and iterative techniques for solving systems of linear equations, root-finding algorithms for nonlinear problems, and interpolation methods for data approximation. Students will gain proficiency in numerical differentiation and integration schemes, as well as in single-step and multi-step approaches for ordinary differential equations. The course further emphasizes the application of finite difference and other numerical schemes to partial differential equations, including parabolic, hyperbolic, and elliptic types, with attention to boundary value problems. By integrating theory with practical computation, the course fosters analytical skills to evaluate accuracy, stability, and convergence, preparing students to apply numerical techniques effectively in engineering, applied sciences, and mathematical modeling contexts.					
Course Outcomes	On successful completion of the course the students shall be able to: **CO1:** Apply the method of separation of variables and Lagrange's method to obtain solutions of partial differential equations. (L3) **CO2:** Apply appropriate techniques to solve one-dimensional heat and wave equations under prescribed initial and boundary conditions. (L3) **CO3:** Employ iterative numerical methods to determine the roots of algebraic and transcendental equations. (L3) **CO4:** Apply numerical differentiation and integration techniques to evaluate derivatives and integrals of given functions. (L3) **CO5:** Apply numerical methods to obtain approximate solutions of ordinary differential equations and systems of nonlinear equations. (L3)					

<table>
<tr><td></td><td colspan="2">CO6: Employ finite difference and iterative methods to obtain numerical solutions of engineering problems modelled by partial differential equations. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="2"></td></tr>
<tr><td>Module 1</td><td>Numerical Methods for Algebraic Equations and Linear Systems</td><td>(12L+4T=16 Sessions)</td></tr>
<tr><td colspan="3">Introduction, 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.
Nodal Voltage Analysis in an IC Circuit.</td></tr>
<tr><td>Module 2</td><td>Numerical Interpolation, Integration, Differentiation and ODEs</td><td>(13L+5T=16 Sessions)</td></tr>
<tr><td colspan="3">Resonant Frequency of an LC Circuit 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, Newton-Raphson method for system of nonlinear equations, Runge-Kutta Method for system of first order ODEs and for second order ODEs, Estimation of MOSFET Drain Current, Delay Estimation in VLSI Interconnects.</td></tr>
<tr><td>Module 3</td><td>Partial Differential Equations and Their Applications</td><td>(11L+3T=16 Sessions)</td></tr>
<tr><td colspan="3">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. 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.
Heat Dissipation in an Integrated Circuit (IC), Crosstalk Analysis Between Interconnects.
Introduction, 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., Nodal Voltage Analysis in an IC Circuit, Resonant Frequency of an LC Circuit</td></tr>
<tr><td>Module 4</td><td>Numerical Methods for PDEs</td><td>(9L+3T =12 Sessions)</td></tr>
<tr><td colspan="3">Finite difference method for PDEs, Scmidt explicit formula, Crank-Nicolson method for parabolic PDEs, explicit finite difference method for hyperbolic PDEs, Gauss-Seidel iteration method for elliptical PDEs.
Heat Diffusion in a Microprocessor, Thermal Simulation of a Silicon Wafer.</td></tr>
<tr><td colspan="3">Targeted Application & Tools that can be used:
• Bubble point pressure estimation, reservoir pressure distribution, well performance analysis, nonlinear flow equations, gas compressibility factor calculations, production optimization problems.
• Reservoir pressure estimation using interpolation, production rate forecasting, velocity and acceleration calculations in pipelines, cumulative production estimation, pressure decline analysis, fluid flow prediction.
• Heat transfer during steam injection, heat loss in oil pipelines, groundwater flow, temperature distribution in reservoirs, enhanced oil recovery processes, contaminant transport modeling.
• Reservoir pressure distribution using finite differences, seismic wave propagation, thermal recovery simulation, hydraulic fracturing studies, fluid flow in porous media, reservoir simulation and forecasting.
Softwares: MATLAB, Mathematica, Maple, Python, GeoGebra, Octave, R, Scilab.</td></tr>
<tr><td colspan="3">Assignment:</td></tr>
<tr><td colspan="3">Assignments will involve theoretical problem-solving and computational implementation using suitable programming tools. The assignments may be undertaken individually or in groups, as decided by the instructor.</td></tr>
<tr><td colspan="3">Text Book
4. E. Kreyszig, Advanced Engineering Mathematics, 11th ed. Hoboken, NJ, USA: John Wiley & Sons, 2025.</td></tr>
</table>

5. B. S. Grewal, *Higher Engineering Mathematics*, 45th ed. New Delhi, India: Khanna Publishers, 2022. 6. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, 8th ed. New Delhi, India: New Age International Publishers, 2022.
References: 1. V. Henner, T. Belozerova, and M. Khenner, Ordinary and Partial Differential Equations. Boca Raton, FL, USA: CRC Press, 2013. 2. W. Ledermann, Multiple Integrals, 1st ed. Cham, Switzerland: Springer. 3. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th ed. Noida, India: Pearson Education, 2002. 4. T. Veerarajan, Engineering Mathematics for First Year. New Delhi, India: Tata McGraw-Hill, 2008. **E-resources/ Web links:** 5. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=EBSCO95_10122025_221436 6. https://presiuniv.knimbus.com/portal/v2/default/viewDetail?searchResultType=ECATALOGUE_BASED&uniqueId=DOAB_1_06082022_9595 7. https://projecteuclid.org/ebooks/institute-of-mathematical-statistics-lecture-notes-monograph-series/multivariate-statistics/toc/10.1214/lnms/1196285102 8. https://www.mdpi.com/books/reprint/1360-advanced-numerical-methods-in-applied-sciences 9. https://www.gutenberg.org/ebooks/33283
Topics relevant to SKILL DEVELOPMENT: The course develops computational modeling, problem-solving, and numerical simulation skills essential for petroleum engineering applications. Students learn to apply numerical methods for approximation, interpolation, integration, and differential equations in real-world engineering applications and integrate mathematical techniques with modern computational tools for reservoir analysis, production optimization, and decision-making in the energy sector.

Catalogue prepared by	**Dr. Mohammad Javed Alam**
Recommended by the Board of Studies on	
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	3	0	0	3
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.					

<table>
<tr><td>Course Out Comes</td><td colspan="3">On successful completion of the course the students shall be able to:
CO1: Apply semiconductor, superconducting, and dielectric principles in problems related to basic electronic devices and their characteristics.
CO2 Make use of quantum mechanics principles, problems involving wave functions, and the uncertainty principle in quantum computing
CO3: Apply vector calculus, problems involving electric and magnetic fields using Gauss's and Stokes' theorems.
CO4: Apply Maxwell’s equations to solve practical problems in electromagnetic theory
CO5: Analyze the principles and characteristics of lasers and optical fibers in communication systems and medical applications.</td></tr>
<tr><td>Course Objective</td><td colspan="3">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.</td></tr>
<tr><td>Course Content:</td><td colspan="3"></td></tr>
<tr><td>Module 1</td><td>Electrical Properties of Semiconductors, Superconductors, And Dielectrics:</td><td>Assignment</td><td>No. of Classes: 10</td></tr>
<tr><td colspan="4">(Classification of materials based on bandgap, Fermi energy and Fermi level, Fermi level in semiconductors, Law of mass action, Electrical conductivity of a semiconductor, Hall effect, Superconductivity, Dielectrics, p-n junctions, Zener diode, Solar cells, I-V characteristics, and LEDs)</td></tr>
<tr><td>Module 2</td><td>Quantum Mechanics</td><td>Assignment</td><td>No. of Classes: 12</td></tr>
<tr><td colspan="4">(Introduction, de-Broglie hypothesis, Heisenberg’s uncertainty principle- statement and physical significance, wave function-properties and physical significance. Time-independent Schrodinger wave equation, Probability density, and normalization of wave function. Wave Function in Ket Notation: Matrix form of wave function, Identity operator, Determination of I|0> and I|1>, Pauli Matrices and its operations on 0 and 1 states, Mention of Conjugate and Transpose, Unitary Matrix U, Examples: 2x2 Matrices and their multiplication (Inner Product), Probability, Orthogonality.)</td></tr>
<tr><td>Module 3</td><td>Electromagnetic Theory</td><td>Term paper</td><td>. No. of classes: 13</td></tr>
<tr><td colspan="4">(Fundamentals of Vector Calculus. Divergence and Curl of Electric field and Magnetic field (static), Gauss’ divergence theorem and Stoke’s theorem. Description of laws of Electrostatics, Magnetism, Faraday’s laws of EMI, Current Density, Equation of Continuity, Displacement Current (with derivation), Maxwell’s equations in vacuum, Numerical Problems.

The wave equation in differential form in free space (Derivation of the equation using Maxwell’s equations), Plane Electromagnetic Waves in vacuum, their transverse nature.)</td></tr>
<tr><td>Module 4</td><td>Lasers And Optical Fibers</td><td>Term paper</td><td>. No. of classes :10</td></tr>
<tr><td colspan="4">(Interactions of radiations with matter, expression for energy density of a system under thermal equilibrium in terms of Einstein’s coefficients, conditions for LASER action using Einstein’s coefficients, Characteristics of laser, conditions and requisites of laser, Principle of optical fibers, Numerical aperture and acceptance angle (Qualitative), Attenuation, Applications: Point to point communication with block diagram, application of optical fibers in endoscopy.</td></tr>
<tr><td colspan="4">Targeted Application & Tools that can be used:</td></tr>
</table>

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 Books: **T1:** Engineering Physics by Avadhanalu, Revised edition, S. Chand Publications,2024. **T2:** Principles of Quantum Mechanics by R Shankar, 2nd edition, springer Publications, 2011. **T3:** Introduction to Electrodynamics by David J. Griffiths,pearson publisher, 4th edition, 2021 **T4:** Introduction to Quantum Mechanics, David J Griffiths, Cambridge University Press, 2019
Reference Books: **R1.** Elementary Solid-state Physics: Principles and Applications by M.A. Omar, 1st Edition, Pearson Publications, 2002. **R2.** Optoelectronics: An Introduction by John Wilson and John Hawkes, 3rd edition, Pearson Publications, 2017. **R3.** Engineering Physics by Gaur and Gupta, Dhanpat Rai Publications, 2012 **Online Resources** 1. eBook: https://presiuniv.knimbus.com/user#/searchresult?searchId=eBook&curPage=0&layout=grid&sortFieldId=doc_title_str&topresult=false&search_within=engineering%20physics 2. Seminar: http://ndl.iitkgp.ac.in/he_document/aklectures/aklectures/11_1_15_978?e=4|*|| 1.CaseStudy: http://ndl.iitkgp.ac.in/he_document/libretexts/libretexts/7d72ef9068399eebe6b0cdbaef5ac663 3. https://nucleares.unam.mx/~martinel/griffiths_4ed.pdf
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	st Academic meeting held on _______________

Academic Council	

Course Code: PHY2505	**Course Title:** Advanced Materials and Quantum Physics for Engineers Lab **Type of Course:** Basic Science Course and Laboratory only	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:** Apply fundamental principles of optics, solid-state physics, and semiconductor physics to experimentally determine key physical parameters such as wavelength, dielectric constant, Fermi energy, and Stefan's constant. **CO2**: Analyze and interpret current–voltage characteristics of electronic and optoelectronic devices including diodes, Zener diodes, LEDs, transistors, and Hall-effect materials under various biasing and field conditions. **CO3:** Demonstrate proficiency in using optical and electronic laboratory instruments such as spectrometers, optical fibers, lasers, Hall-effect setups, semiconductor characterization kits, and thermal radiation apparatus. **CO4:** Analyse experimental data using appropriate graphical methods, error analysis, and proportionality relationships to validate physical laws such as Stefan–Boltzmann law, Hall-effect relations, and semiconductor transport behavior. **CO5:** Evaluate structured laboratory reports by documenting procedures, observations, results, and conclusions with professional and ethical practices.					
Course Objective	The objective of this course is to familiarize students with fundamental experimental methods in optics, semiconductor physics, solid-state physics, and thermal radiation through a series of well-designed laboratory experiments. The course aims to develop hands-on skills in precise measurement, device characterization, and use of modern optical and electronic instrumentation, while strengthening the ability to analyze experimental data, verify physical laws, and interpret material and device properties. Through experiential learning, students will enhance their experimental competence, scientific reasoning, and problem-solving skills relevant to engineering and technological applications.					
List of Laboratory Tasks:						

Course Content:	**Total 30 sessions**		
Experiment 1	Experimental	Data Collection	Analysis and Interpretation
Determine the wavelength of monochromatic light, such as sodium light, using Newton's rings.			
Experiment 2	Experimental	Data Collection	Analysis and Interpretation
To determine the wavelength of semiconductor diode Laser			
Experiment 3	Experimental	Data Collection	Analysis and Interpretation
To determine the proportionality of Hall Voltage, magnetic flux density and the polarity of Charge carrier.			
Experiment 4	Experimental	Data Collection	Analysis and Interpretation
To study the I-V characteristics of a given zener diode in forward and reverse bias conditions			

Experiment 5	Experimental	Data Collection	Analysis and Interpretation
To study input and output characteristics of a given Transistor			
Experiment 6	Experimental	Data Collection	Analysis and Interpretation
Determination of Fermi energy of copper coil			
Experiment 7	Experimental	Data Collection	Analysis and Interpretation
Determination of Dielectric constant of given material			
Experiment 8	Experimental	Data Collection	Analysis and Interpretation
Calculate the numerical aperture and study the losses that occur in optical fiber cable.			
Experiment 9	Experimental	Data Collection	Analysis
Plotting I-V characteristics in forward and reverse bias for LEDs			
Experiment 10	Experimental	Data Collection	Analysis
Determination of Stefan’s constant and verification of Stefan-Boltzmann Law.			

	Any 8 experiments will be conducted out of 10	

Continuous Internal Assessment:

- Midterm exam
- Experimental Evaluation
- Viva-voce
- Endterm exam

Text Book

1. A text book of Engineering physics practical – Dr. Ruby Das
2. Physics lab manual

References:

Video Links: https://www.youtube.com/@dr.spbasavaraju4939

Books: S. O. Pillai, *Solid State Physics*, 7th Edition, New Age International Publishers, New Delhi. *(Hall Effect, Fermi energy, dielectric properties, semiconductor basics)*

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	Dr. Charan Prasanth S
Recommended by the Board of Studies on	13th BOS conducted on 6th June 2025
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	3	0	0	3
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 electrical and electronics engineering. The course also aims to enhance the knowledge of chemical composition and properties of chemical molecules as/in electronic materials & devices, advanced renewable energy systems. It will also cultivate an ability to identify chemistry in each of smart engineered materials and interpret solutions for the challenges connected to display and memory systems, sensor and smart technologies, advanced energy storage & conversion systems, nanofabrication and environmental management. It targets to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications.			
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: CO1 Apply the band theory of solids for elucidation of types of electronic materials Outline the chemistry behind electronic materials and devices. CO2 Explain the role of photo & electroactive materials in display systems and organic, polymeric and hybrid materials in memory systems. CO3 Explain the role of electrochemical sensors and synthetic materials in modern sensing and packaging solutions. CO4 Analyze various electrochemical energy systems including photovoltaics in terms of their principles, classifications & applications and their waste management for sustainable energy solutions. CO5 Explain the importance of nanomaterials and thin film deposition techniques in device fabrication.			
Course Content:				
Module 1	Introduction to electronic materials Conductors, Semiconductors & Insulators	Case study	Data Collection and analysis	8 Classes
Conductors, Semiconductors & Insulators: Definition of conductors, semiconductor and insulators based on band theory. Semiconductors: Introduction, production of electronic grade silicon from Czochralski process (CZ) and Float Zone (FZ) methods, Chemical and electronic properties & applications of inorganic semiconductors (SiGe, GaAs, InP). Self-learning topics: Properties and functions of Cu & Quartz.				
Module 2	Chemistry of display & memory systems	Assignment	Data Collection	9 Classes
Display Systems: Photo and electroactive materials, Liquid crystals for display (LCD) - Introduction, types, principle, properties, Basics of LED: Organic light emitting diode (OLED) and light emitting electrochemical cell (LEC). Memory Systems: Introduction, concepts of electronic memory, Classification of electronic memory device – Transistor, capacitor, resistor, charge transfer and memristor, Types of materials for memory systems - organic molecules, polymeric materials, organic-inorganic hybrid materials, Applications Self-learning topics: Biocomposite based memory devices				
Module 3	Chemistry of sensors & smart materials Sensors	Case study	Data analysis	8 Classes
Introduction, types; chemiresistor, principle and applications of electrochemical sensors with examples (glucose & VOC sensing), advanced sensor technologies mimicking human sensory organs (e-skin, e-nose) MEMS & NEMS – Introduction, components, classification, applications. Smart materials (RFID & IONT): Introduction, applications of carbonaceous/polymeric materials in smart packaging systems and data analysis Self-learning topics: Fullerene as advanced materials in organic electronics, Gas sensor-Application CO sensing				

Module 4	Advanced energy systems & e-waste management Electrochemical energy systems	Case study	Data Collection and analysis	10 Classes

Introduction to electrochemistry Battery - Basic concepts of batteries and characteristics, classification, Lithium-ion batteries; Next generation batteries Supercapacitor - Classification, principle and applications in hybrid vehicles Fuel cells - H2-O2 fuel cell, Principle, working and their applications. Green hydrogen - Importance and principle of generation
Photovoltaics: Principle, Types (organic & inorganic solar cells, quantum dot sensitized solar cells(QDSSC's))
E-waste Management & Green Chemistry: Introduction, e-waste hazard, battery waste recycling and management, Carbon footprint and sequestration, 12 principles of green chemistry
Self-learning topics: Methanol fuel cell, Metal-air battery

Module 5	Nanotechnology and device fabrication Nanotechnology	Case study	Data Collection and analysis	10 Classes

Introduction, Classification of nanomaterials based on dimensionality, quantum confinement, Size dependent properties, Synthesis- Sol-gel method for thin films, Synthesis, properties and applications of carbon nanomaterials - CNT & Graphene
Nanofabrication: lithography, Nano imprinting and applications, Manufacturing of semiconductor chips
Thin Film Deposition Techniques: Principle and applications of Chemical vapor deposition (CVD), Types – Plasma enhanced chemical vapor deposition (PECVD) and MetalOrganic chemical vapor deposition (MOCVD).
Self-learning topics: Applications of nanotechnology in Nanoelectronics and health & hygiene.

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:
R1. Advanced Semiconducting Materials and Devices, K M Gupta & Nisha Gupta (2016), Springer
R2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications (2018), Cambridge University Press
R3. Chemistry in microelectronics, Yannick Le Tiec, 2013, Wiley Publications, ISBN: 9781848214361.
R4. Electronics properties of materials, Rolf E, Hummel, 2012, Springer Publications New York, 4th Edition, ISBN 9781441981639. Publishers, ISBN: 9781608055425
R5. Smart nanomaterials for sensor application, Li S, Ge Y, Li H, 2012, Bentham Science
R6. Energy storage and conversion materials, Skinner S, 2019, Royal society of chemistry, ISBN: 9781788010900.

Online Resources .
1.https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_97006 2.
2.https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=EBSCO95_30102024_48504&xIndex=2 3.

3.https://research.ebsco.com/c/n5guci/search/details/sfc3dnpvkb?db=nlebk&limiters=None &q=chemistry%20of%20materials 4. https://www.mdpi.com/books/pdfview/book/1069 5. 4.https://www.mdpi.com/books/pdfview/book/333 6. 5.https://www.bloomsburycollections.com/book/fuel-an-ecocritical-history/ 7. 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	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. This course is designed to cater to Environment and Sustainability.					
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 Examine the amount of acids in domestic and industrial waste using conductometric and pH sensors. CO2 Determine the amount of metal ions in electronic waste using potentiometric and optical sensors. CO3 Employ the suitable titration method to quantify the metal ions in industrial waste. CO4 Apply viscometry method to find the viscoelastic property of organic solvents. CO5 Recognize the suitable method to prepare, fabricate and recover the industrially important materials					
Course Content:						

1.Conductometric method of determination of strength of a strong acid in battery electrolyte (Conductometric sensor). 2.Determination of pKa of organic acid in industrial wastewater using pH meter (pH sensor). 3.Estimation of Iron using potassium dichromate by Potentiometric method (Electrochemical sensor). 4.Colorimeter estimation of copper in industrial effluent (optical sensor). 5. Conductometric method for the determination of strength of a mixture of acids (e-waste recycling). 6.Determination of viscosity coefficient of lubricant by Ostwald's viscometer (Viscoelastic property). 7.Iodometric estimation of metals (copper) in electronic discards. 8.Estimation of iron using Std. Potassium permanganate solution. 9.Flame photometric estimation of sodium in e-waste management (Optical sensor) 10.Synthesis of polyaniline for gas sensor application (Demonstration experiment).
Continuous Internal Assessment: • Midterm exam • Experimental Evaluation • Viva-voce
Text Book T1. Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S. Chand Publications, New Delhi (2022). T2. Vogel's text book of practical organic chemistry 5th edition T3. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications. T4. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi
References: R1. Engineering Chemistry Laboratory Manual (English, Paperback, Dr. Manoj Kumar Solanki), Edu-creation Publishin 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

Course Code: CIV1200	Course Title: Foundations of Integrated Engineering Type of Course: Theory Only	L-T- P- C	2	0	0	2
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the foundational principles, tools, and approaches essential to modern engineering practice. The course also integrates sustainability and systems thinking, highlighting the role of engineers in achieving sustainable development through material efficiency, sustainable design, and case-based learning. Students will gain exposure to emerging technologies such as IoT, robotics, AI, machine learning, and 3D printing. Knowledge in digital modeling, project planning, simulation, and programming are developed to prepare students for integrated engineering workflows					
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 core concepts of problem-solving, ethics, environment, and safety in engineering projects. CO2 - Describe sustainability principles and the engineer's role in sustainable development. CO3 - Apply sustainability assessment tools to evaluate the environmental impact. CO4 - Explain the basic concepts of automation, IoT, robotics, AI, machine learning, and 3D printing in the context of engineering applications. CO5 - Describe the functions of digital modeling, simulation, and project management tools used in integrated engineering projects.					
Course Content:						

Module 1	Foundations of Engineering Practice	Assignment	Case studies	8 Sessions
Basics of Engineering Problem Solving and Engineering Mechanics, MultiDisciplinary Project Collaboration, Creative Thinking and Innovation in Engineering, Ethics, Environment, and Social Responsibility, Managing Cost, Safety, and Risks in Projects.				
Module 2	Sustainability and Systems Thinking in Engineering:	Assignment	Article Review	10 Sessions
Introduction to Sustainability and Systems Thinking, Role of Engineers in Driving Sustainable Development, Sustainable Engineering Tools and Approaches, Energy and Material Sustainability in Engineering, Sustainable Design Principles, Practices and Case Studies				
Module 3	Mechanical Engineering in Action	Assignment & Quiz	Data Collection	12 Sessions
Introduction to Automation and Smart Technologies, Basics of IoT and Robotics, Introduction to AI and Machine Learning, Fundamentals of 3D Printing and Its Uses. Design and drafting using digital modeling for components, systems, and structures; Project planning and management - scheduling, resource allocation, and tracking; Simulation and analysis for virtual testing of engineering problems; Programming and scripting for automation, problem solving, and system control.				

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 Books: T1: William C Oakes & Les L Leone, "Engineering Your Future: A Comprehensive Introduction to Engineering", Oxford University Press, 9th Edition, 2018 T2: Allen, D. T. and Shonnard, D. R., "Sustainability Engineering: Concepts, Design and Case Studies", Prentice Hall, 1st Edition, 2011. T3: Bradley. A.S; Adebayo, A.O., Maria, P., "Engineering applications in sustainable design and development", CL Engineering, 2015 T4: Ian Gibson, David Rosen, & Brent Stucker, "Additive Manufacturing Technologies", Springer, 3rd Edition, 2021 T5: Sudip Misra, "The Internet of Things: Enabling Technologies, Protocols, and Use Cases", Wiley, 2nd Edition, 2022
Reference Books: R1: Bradley. A.S; Adebayo, A.O., Maria, P., Engineering applications in sustainable design and development, CL Engineering. 2015 R2: Robert McGinn, "The Ethical Engineer: Contemporary Concepts and Cases", Princeton University Press, 1st Edition, 2020 R3: David Buchla, "Renewable Energy Systems: A Smart Energy Systems Approach", Pearson, 2nd Edition, 2023 R4: Charles Platt, "Make: Electronics: Learning Through Discovery", Make Community, 3rd Edition, 2021. Online Resources 1. New Industry 4.0 Advances in Industrial IoT and Visual Computing for Manufacturing Processes https://www.mdpi.com/books/reprint/2109-new-industry-4-0-advances-in-industrial iot-and-visual-computing-for-manufacturing-processes 2. Additive Manufacturing Technologies and Applications https://www.mdpi.com/books/reprint/462-additive-manufacturing-technologies-and applications 3. Sustainability in Construction Engineering https://www.mdpi.com/books/reprint/754-sustainability-in-construction-engineering

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. 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: CO1 Identify and interpret the basic principles, symbols, and conventions of engineering graphics, including lines, scales, lettering, and dimensioning. CO2 Construct basic geometrical shapes and engineering curves (such as ellipse, parabola, cycloid) using appropriate drawing instruments and techniques CO3 Apply orthographic projection techniques to draw points, lines, planes, and solids in various orientations. CO4 Generate and interpret sectional views, true shapes, and developments of surfaces of simple objects and solids. CO5 Visualize and convert 3D objects into isometric views and vice versa from orthographic projection CO6 Analyse orthographic and isometric views to visualise, interpret, and evaluate the geometry of objects including hidden detail			
Course Content				
Module 1	Introduction to Drawing	Assignment	Standard technical drawing	2 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	13 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	10 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	5 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. Web Resources: 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.			

Course Code: EEE1200	Course Title: Basics of Electrical and Electronics Engineering. Type of Course: Engineering Science - Theory	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	NIL					

Anti-requisites	NIL			
Course Description	This is a fundamental Course is designed to know the use of basics of electrical and electronics engineering principles in various fields of Engineering. The course emphasises the characteristics and applications of electrical and electronic devices. The course also emphasizes the working, analysis of electrical circuits. Additionally, this course ensures a foundation for future interdisciplinary applications in electrical machines manufacturing, power system, robotics, automation, communication, and oil refineries.			
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 course the students shall be able to: CO1 Solve DC and AC electrical circuits using KVL and KCL. CO2 Calculate various electrical parameters in AC systems CO3 Illustrate the working principle of the transformer, induction machine, and special machines to obtain characteristics. CO4 Analyze the behavior of the semiconductor diode, zener diode, and rectifier circuit. CO5 Determine the operating parameters of BJT and MOSFET.			
Course Content:				
Module 1	Introduction to Electrical Circuits	Assignment/ Quiz	Numerical solving Task	9 Sessions
DC Circuits: Ohm's law, Kirchhoff's voltage and Kirchhoff's current laws, concept of circuit and network, types of elements, series-parallel connections of a resistive network. Electromagnetic Induction: Faraday's laws of electromagnetic induction, types of inductance, self-inductance, Mutual inductance, and coefficient of coupling, Practical Applications.				
Module 2	AC Circuits	Assignment/ Quiz	Memory Recall based Quizzes	9 Sessions
AC Circuits: Generation of sinusoidal voltage, Basic terminologies in AC quantity, Analysis of R, L, C, Series RL, Concept of active power, reactive power, and power factor, real-world applications. Three-phase AC Circuits: Introduction to the three-phase system, Advantages of three-phase system over the single-phase system, and relation between line and phase values in Star and Delta connections, Practical Applications.				
Module 3	Fundamentals of Electrical Machines	Assignment/ Quiz	Memory Recall-based Quizzes	9 Sessions
Electrical Machines: Single-phase transformers: Principle of operation, Types and construction of transformers. EMF equation. AC Motor: Principle Operation of Induction Motors and its characteristics, Industrial and Domestic Application. Special Machines: BLDC, Stepper motor and applications.				
Module 4	Semiconductor and Diode Applications	Assignment/ Quiz	Numerical solving Task	9 Sessions

Semiconductor and Diode Applications: Types of semiconductors (intrinsic and extrinsic), P-N junction diode - Ideal and practical behaviour, Diode forward and reverse characteristic, and Zener diode and its characteristics, half-wave and full-wave rectifier, applications. 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.				
Module 5	Transistor and Switching Device	Assignment/ Quiz	Numerical solving Task	9 Sessions
Transistor characteristics, Current components, types of BJT Configurations and their current gains. Operating point, Applications. MOSFET: Construction, Principle of Operation, Depletion MOSFET, Comparison of BJT and MOSFET, Practical Applications.				
Text Books: T1: Kothari D. P. & Nagrath I. J., “Basic Electrical and Electronics Engineering”, Tata McGraw Hill Education. T2: 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. T3: A.P.Malvino, Electronic Principles,7th Edition, Tata McGraw Hill,2007. T4: J. Millman, C. C. Halkias and C. D. Parikh, “Millman’s Integrated Electronics”, McGraw Hill Education, 2nd Edition.				
Online Resources 1. https://presidencyuniversity.linways.com 2. https://www.digimat.in/nptel/courses/video/108105112/L01 “Fundamentals of Electrical Engineering - Basic Concepts, Examples” 3. Seminar Topic: https://nptel.ac.in/courses/108/105/108105153/ “Electrical Measurements” 4. Video lectures on “Electronic Devices” by Prof. Dr. A. N. Chandorkar, IIT Bombay http://www.satishkashyap.com/2013/03/video-lectures-on-electron-devices-by.html 5. Video lectures on “Analog Electronic Circuit”, by Prof. Shouribrata Chatterjee, IIT Delhi 6. https://www.youtube.com/watch?v=9g9dowLjmCA&list=PLp6ek2hDcoNDAw1BehPFaz Z5ogPV8UlQa 7. Video lectures on “PN Junction Diodes”, by Prof. Chitralekha Mahanta, IIT Guwahati. https://www.youtube.com/watch?v=L28F1Oenyds				
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.			

<table>
<tr><td>Course Code:
EEE1251</td><td>Course Title: Basics of Electrical and Electronics Engineering Laboratory
Type of Course: ESC - Laboratory</td><td>L-T-P-C</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">Nil</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">Nil</td></tr>
<tr><td>Course Description</td><td colspan="6">This fundamental laboratory provides an opportunity to validate the concepts taught in the basics of electrical and electronics engineering and enhances the ability to visualize real system performance, using both hardware and simulation tools.</td></tr>
<tr><td>Course Objective</td><td colspan="6">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>Basic skill sets required for the laboratory</td><td colspan="6">The students shall be able to develop:
1) An attitude of enquiry.
2) Confidence and ability to tackle new problems.
3) Ability to interpret events and results.
4) Ability to work as a leader and as a member of team.
5) Assess errors and eliminate them.
6) Observe and measure physical phenomenon.
7) Write Reports.
8) Select suitable equipment, instruments and materials.
9) Locate faults in systems.
10) Skills for setting and handling equipment.
11) The ability to follow standard test procedures.
12) An awareness of the need to observe safety precautions.
13) To judge magnitudes without actual measurement.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of the course, the students shall be able to:
1. Demonstrate the behavior of passive elements and fundamental electrical circuit laws
2. Determine the power factor, impedance, and phase relationship of R and RL loads under AC supply conditions. –
3. Develop electrical circuits and three-phase supply systems using MATLAB/Simulink to study resistance, voltage, and current characteristics
4. Analyze the performance characteristics of electrical machines, including single-phase transformers and three-phase induction motors, under different operating conditions.
5. Examine the output characteristics and performance parameters of half-wave and full-wave rectifiers.
.
6. Illustrate the performance characteristics of Zener diode and MOSFET under different operating conditions.</td></tr>
</table>

Course Content:	List of Laboratory Tasks: **Experiment No 1:** Familiarization of passive elements. Level 1: Identify and understand the function and ratings of basic passive elements. Level 2: Study the behavior of passive elements in simple electrical circuits by measuring voltage, current, and impedance. **Experiment No 2:** Experimental Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL). Level 1: Study and Verify KVL and KCL for the given electrical Circuit. **Experiment No 3:** Determination of Power Factor, and Impedance for R and RL Loads. Level 1: Determine the power factor and impedance of R and RL loads under steady-state AC supply conditions. Level 2: Analyze the effect of inductance on power factor, impedance, and phase angle for RL loads under varying load conditions. **Experiment No 4:** Modeling and Simulation of effective resistances in different circuit connections Using Simulink. Level 1: Model and simulate series and parallel resistor circuits in Simulink and determine their effective resistance. Level 2: Analyze the effect of different resistor combinations on total resistance, current distribution, and voltage drop. **Experiment No 5:** Simulation and analysis of line and phase voltages in Star-connected and Delta- connected supply systems. Level 1: Model and simulate star-connected and delta-connected three-phase supply systems and observe line and phase voltages. Level 2: Analyze and compare the relationship between line and phase voltages in star and delta connections. **Experiment 6:** Determination of transformation ratio of a Single-Phase Transformer Under different tapping conditions. Level 1: Determine the transformation ratio of a single-phase transformer under no-load condition for various tap settings. Level 2: Analyze the effect of different tapping conditions on secondary voltage, regulation, and transformer performance. **Experiment No. 7:** Study of the speed-torque characteristics of a Three-Phase Induction Motor. Level 1: Study and analyze the speed–torque characteristics of a three-phase induction motor. Level 2: Evaluate the effect of supply voltage and current on motor performance parameters such as slip, and torque. **Experiment 8:** Performance Analysis of Half-Wave and Full-Wave Rectifier Circuits Using Simulink. Level 1: Model and simulate half-wave and full-wave rectifier circuits in Simulink and analyze their output waveforms. Level 2: Evaluate and compare rectifier performance parameters such as ripple factor, efficiency, and output voltage. **Experiment 9:** Study of the characteristics of a Zener Diode. Level 1: Study the forward and reverse V–I characteristics of a Zener diode using DC analysis. Level 2: Analyze the Zener breakdown characteristics and determine the Zener voltage and regulation behavior. **Experiment 10:** Study of the Output and Transfer Characteristics of a MOSFET.

	Level 1: Study, analyze and implement the output characteristics of a MOSFET under different gate-source voltage conditions and observe their results. Level 2: Analyze the transfer characteristics of a MOSFET and evaluate key parameters such as threshold voltage and transconductance.

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 SIMULINK

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.

Course Material

1. Basics of Electrical and Electronics Engineering Laboratory Manual, Presidency University, Bengaluru.

Text Book:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 4th Edition, McGraw Hill Education, New Delhi, 2019.
2. B. L. Theraja and A. K. Theraja, A Textbook of Electrical Technology, Volume-I: Basic Electrical Engineering in SI Units, 24th Edition, S. Chand Publishing, New Delhi, 2024.

References

1. John Hiley, Keith Brown and Ian McKenzie-Smith, Hughes Electrical and Electronic Technology, 12th Edition, Pearson Education, 2016.
2. S. K. Bhattacharya and D. Devaraj, Basic Electrical and Electronics Engineering, 2nd Edition, Pearson Education India, 2017.
3. T. K. Nagsarkar and M. S. Sukhija, Principles of Basic Electrical Engineering, 1st Edition, Oxford University Press, 2018.
4. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 12th Edition, Pearson Education, 2019.
5. A. K. Maini and Varsha Agrawal, Electronic Devices and Circuits, 2nd Edition, Wiley India, 2019.
6. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits, 8th Edition, Oxford University Press, 2019.

Online Resources:

1. https://presidencyuniversity.linways.com
2. https://www.digimat.in/nptel/courses/video/108105112/L01 "Fundamentals of Electrical Engineering - Basic Concepts, Examples"
3. 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
4. NPTEL lectures on "Rectifiers", by Prof. G. Bhuvaneswari, IIT Delhi https://nptel.ac.in/courses/108102145
5. NPTEL Lectures on "Electrical Machines II", by Prof. G. Sridhara Rao, IIT Madras. https://nptel.ac.in/courses/108106072

Topics relevant to "EMPLOYABILITY SKILLS": All the experiments which are listed are for **Skill Development** through **Experiential Learning Techniques**. This is attained through the assessment component mentioned in course handout.

Topics relevant to "HUMAN VALUES & PROFESSIONAL ETHICS": Standard test methods, safety procedure.

Catalogue prepared by	Dr. Priti Das
Recommended by the Board of Studies on	BoS No 22, Held on 18/12/2025
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code:
ECE1512</td><td colspan="3">Course Title: Design Thinking in Practice</td><td>L- T-P-C</td><td>2</td><td>0</td><td>2</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 course introduces students to Design Thinking frameworks for identifying real-world user needs and transforming them into innovative technology solutions using embedded systems, sensors, IoT platforms, and AI-enabled computing devices. The course blends human-centered innovation methodologies with hands-on development using Arduino, Aries, ESP32, Raspberry Pi, NVIDIA Jetson, and GPU-based embedded platforms. Students will learn problem identification, ideation, rapid prototyping, sensor integration, edge AI, and intelligent system development for applications in smart automation, healthcare, agriculture, robotics, and Industry 5.0. The course emphasizes experiential and project-based learning to build future-ready innovators capable of developing scalable, intelligent, and socially impactful products.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is to enhance students' employability skills through participative learning techniques by integrating Design Thinking, embedded systems, IoT, and AI technologies to develop innovative, intelligent, and socially impactful real-world solutions.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of the course, the students shall be able to
1. Explain the principles, framework, and process of design thinking
2. Formulate Engineering Problem from user challenges, customer expectations, and market opportunities using design thinking process.
3. Analyze the Engineering Problem using the basic concepts of microcontroller and sensory devices.
4. Find alternate methods to solve the engineering problem by working with embedded computing platforms.
5. Develop functional prototypes using embedded boards, sensors, and an intelligent system for the chosen method
6. Validate prototype performance through testing, user feedback, and iterative improvements.</td></tr>
<tr><td>Course Content</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>Introduction to Design Thinking</td><td></td><td colspan="2"></td><td colspan="4">6 Sessions</td></tr>
</table>

Introduction to Design Thinking – Importance of Design Thinking – History of Design Thinking-Design Thinking Framework - Design Thinking process - Empathise –Define – Understanding Purpose - Ideate - What is Creativity? -Thinking Differently – Basic Rules of Design Thinking – The Creativity Heart Set – Everyone is a Designer - Activity-based with case studies				
Module 2	**Basic Concepts of Microcontrollers and Sensory Devices**			**8 Sessions**
Introduction to Arduino, ESP and NodeMCU - Pin Configuration and Architecture - Device and Platform Features - Concept of Digital and Analog Ports - Familiarizing with Arduino Interfacing Board – Programming using Arduino IDE and Embedded C - Datatypes and Variables - I/O Functions – Sensors, types and its applications - Humidity Sensor - Temperature Sensor - Water Detector / Sensor - PIR Sensor - Ultrasonic Sensor - Connecting Switches and Actuators - Sensor Interface with ESP Microcontroller - Various Cloud Platforms				
Module 3	**Working with Embedded Computing Platforms and 3D printing technology**			**8Sessions**
Introduction to Raspberry Pi boards, pin diagram, different types of Raspberry Pi boards and their applications, Configuration of Raspberry Pi boards - LED and switch control – Exploring various libraries and their functions. GPU fundamentals – Configuration of Jetson Nano board, Working with H200 GPU Servers. Introduction to 3D Printer: 3D Printer technology and its working Principles, Applications. Introduction to online Simulators: Working with Tinker CAD Simulator.				
Module 4	**Prototype Development and Validation Techniques**			**8 Sessions**
Importance of Prototyping in Design Thinking – Concept Refinement Using Prototypes – From Idea to Functional Prototype – User Testing and Validation – Iteration and Design Optimization – Prototype Readiness for Product Development (DFM & Market Feasibility – overview) – Activity-based with case studies.				
Prototype Development Tasks: **Total Sessions: 30** 1. Smart Illumination System Design using Arduino 2. Intelligent Plant Health Monitoring System. 3. Aries Rover Drive and Control System Development 4. IoT-Based Environmental Intelligence System using ESP32 5. Edge Computing Platform Setup using Raspberry Pi 6. Raspberry Pi-Based Smart Lighting Controller 7. VoiceX: AI-Powered Smart Home Automation System 8. VisionAI: Intelligent Object Recognition System. 9. Smart Traffic Management System using NVIDEA Jetson Nano 10. High-Performance AI Vision Analytics using H200-GPU Computing. 11. Digital-to-Physical Product Prototyping through CAD and Additive Manufacturing.				

Topics: Types of embedded boards, Thonny Python, Python IDLE, sensors, 3D Printer, Jetson Nano board, GPUs

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, Aries, ESP32, Raspberry Pi, and sensors can be applied. The flexibility and affordability of all embedded boards, 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, such as Arduino IDE, Blynk console, Tinker CAD, Thonny Python, Python IDLE, etc.

Project work/Assignment:

- **Projects:** At the end of the course, students will be completing the project work on solving many real-time problem statements on different domains, such as women-centric, agritech, medtech, climate cell, robotics, drones, and smart cities etc.
- **Book/Article review:** At the end of each module, a book reference or an article topic will be given to an individual or a group of students. They need to refer to the library resources and write a report on their understanding of the assigned article in an appropriate format. Presidency University Library Link
- **Presentation:** There will be a review presentation (Phase 1, Phase 2, and Phase 3) from among the students' groups, where the students will be given a project, and they have to demonstrate the working and discuss the applications for the same

Textbook(s):

1. Thinking Design by S Balaram. New Delhi [India]: Sage Publications Pvt. Ltd. 2010. eBook. Database: eBook Collection (EBSCOhost)
2. Monk Simon, "Programming Arduino: Getting Started with Sketches", McGraw-Hill Publications, Second Edition
3. Monk Simon "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", Publisher(s): O'Reilly Media, Inc., ISBN: 9781098130923, Fourth Edition.
4. CUDA by Example: An Introduction to General-Purpose GPU Programming. *CUDA by Example: An Introduction to General-Purpose GPU Programming*. Addison-Wesley Professional, 2010.

References:

1. Design Thinking by Clarke, Rachel Ivy. Series: Library Futures, Vol. 4. Chicago: ALA Neal-Schuman. 2020. eBook., Database: eBook Collection (EBSCOhost)
2. Neerparaj Rai, "Arduino Projects for Engineers," BPB Publishers, first edition, 2016.
3. Stewart Watkiss "Learn Electronics with Raspberry Pi" Apress Berkeley, CA. Second edition,2020. ISBN978-1-4842-6348-8
4. Jo Prusa, "Basics of 3D printing", Prusa Research, 3rd edition.
5. Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi (Series in Sensors)", CRC Press, 1st Edition. 2018.
6. Professional CUDA C Programming. *Professional CUDA C Programming*. Wrox Press, 2014.

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 thingshttps://nptel.ac.in/courses/106105166>
6. Getting Started with Jetson Nano - https://www.youtube.com/watch?v=DVfmw3Ftu3I

E-content:

1. Tim Brown, "Design Thinking," Harvard Business Review, vol. 86, no. 6, pp. 84–92, Jun. 2008.
2. Rolf Faste, "Ambidextrous Thinking," in Innovations in Mechanical Engineering Curricula for the 1990s, American Society of Mechanical Engineers, 1994, pp. 1–6.
3. M. H. Hemanth Kumar, Ravi Pratap Singh, Nishu Sharma, and Pragya Singh, "IoT Based Smart Security System Using Arduino," *Journal of Emerging Technologies and Innovative Research (JETIR)*, vol. 8, no. 8, Aug. 2021.
4. Basil and Eliza Sawant, S. D., "IoT-Based Traffic Light Control System Using Raspberry Pi," in *Proceedings of ICECDS 2017*, 2017. DoI: 10.1109/ICECDS.2017.8389604.
5. Espressif Systems, "ESP32 Series Datasheet," 2024.
6. Josef Průša, "Open-Source 3D Printers and the RepRap Project," *RepRap Magazine*, 2018.

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

Catalogue prepared by	Dr. Divyarani M S, Dr. M Manikandan
Recommended by the Board of Studies on	BoS Number:

Date of Approval by the Academic Council	Academic Council Meeting No. ___ dated on _____________

Course Code: **CHE7601**	**Environmental Studies** **Type of Course: Thoery**	**L- T- P- C**	-	-	-	-
		Contact hours	-	-	-	-
CoursePre-requisites	NIL					
Anti-requisites	NIL					
Course Description	This course is designed to create awareness towards environment and sustainability. This course aims to familiarize students with fundamental environmental concepts and their relevance to business operations, preparing them to address forthcoming sustainability challenges. It is designed to equip students with consciousness and knowledge needed to make decisions that account for environmental consequences, fostering environmentally sensitive and responsible future managers. **This course is designed to cater to Environment and Sustainability**					
Course Objective	The objective of the course is to "**create awareness towards environment and sustainability**".					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Describe the issues related to natural resources, ecosystems and biodiversity 2. Identify environmental hazards affecting air, water and soil quality 3. Discuss the importance of healthy environment and finding the sustainable methods to protect the environment 4. Explain environmental concerns through changes in environmental processes, policies, and decisions					
Course Content:						
Module 1	**Understanding Environment, Natural Resources, and Sustainability**					
Topics: Classification of natural resources, issues related to Population growth and their overutilization, and strategies for their conservation. Water, air, soil, mineral, energy and food source. Effect of human activities on natural resources. Concept of sustainability- Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs; Sustainable practices in managing resources, including deforestation, water conservation, Desalination – types, energy security, and food security issues, Life Cycle thinking and Circular Economy.						
Module 2	**Ecosystems, Biodiversity, and Sustainable Practices**					
Topics: Ecosystems and ecosystem services: Various natural ecosystems, Major ecosystem types in India and their basic characteristics; forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance.						

The importance of biodiversity, Types of biodiversity, Biodiversity and Climate Change, the threats it faces, hotspots, and the methods used for its conservation. Strategies for in situ and ex situ conservation, mega diverse nation.			
Module 3	**Environmental Pollution, Waste Management, and Sustainable Development**		
Topics: Types of pollution- Chemical, - Biological, Biomedical, noise, air, water, soil, thermal, radioactive and marine pollution, and their impacts on society. Urbanization and Urban environmental problems; effects, and mitigation. Causes of pollution, such as global climate change, ozone layer depletion, the greenhouse effect, and acid rain, with a particular focus on pollution episodes in India. Importance of adopting cleaner technologies; Solid waste management; Sustainable Materials and Technologies: Biodegradable and compostable materials, Recycled and reclaimed materials (E-waste management), Sustainable manufacturing processes.			
Module 4	**Social Issues, Legislation, and Practical Applications**		
Topics: Overview of key environmental legislation and the judiciary's role in environmental protection, including the Water (Prevention and Control of Pollution) Act of 1974, the Environment (Protection) Act of 1986, and the Air (Prevention and Control of Pollution) Act of 1981. Hazardous waste Rule 1989, Biomedical Waste handling 1998, Fly Ash Rule 1999, Municipal Solid Waste Rule 2000, Battery Rules 2001, E- Waste Rules 2011, Plastic waste management Rules 2016, Construction Demolition waste Rules 2016 National Biodiversity Action Plan (NBAP) Major International Environmental Agreements: Convention on Biological Diversity (CBD), The Biological Diversity (Amendment) Act, 2023, United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement. Major International organisations and initiatives: United Nations Environment Programme (UNEP), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC).			
Targeted Application & Tools that can be used: Application areas are Energy, Environment and sustainability Tools: Online Tools – NPTEL and Swayam.			
Project work/Assignment:			
Assessment Type • Online exams (MCQs) will be conducted by the department of Chemistry.			
Online Link*: 1) Lecure by Dr. Samik Chowdhury, Dr. Sudha Goel, NPTEL course: Environmental Science, https://nptel.ac.in/courses/109105203, 2024. 2) Lecture by Dr. Padmavati, Dr Narendran Thiruthy, NPTEL Course: Biodiversity Protection, Farmers and Breeders Rights, https://nptel.ac.in/courses/129105008, 2024. * Other source links are available in below Resources link.			
Text Book 1. G. Tyler Miller and Scott Spoolman (2020), Living in the Environment, 20^{th} Edition, Cengage Learning, USA 2. Poonia, M.P. Environmental Studies (3rd ed.), Khanna Book Publishing Co. 3. Bharucha, E. Textbook of Environmental Studies (3rd ed.) Orient Blackswan Private Ltd.			

4. Dave, D., & Katewa, S. S. Text Book of Environmental Studies. Cengage Learning India Pvt Ltd.
5. Rajagopalan, R. Environmental studies: from crisis to cure (4th ed.). Oxford University Press.
6. Basu, M., & Xavier Savarimuthu, S. J. Fundamentals of environmental studies. Cambridge University Press.
7. Roy, M. G. Sustainable Development: Environment, Energy and Water Resources. Ane Books.
8. Pritwani, K. Sustainability of business in the context of environmental management. CRC Press.
9. Wright, R.T. & Boorse, D.F. Environmental Science: Toward A Sustainable Future (13th ed,). Pearson.

Reference Books

1. Varghese, Anita, Oommen, Meera Anna, Paul, Mridula Mary, Nath, Snehlata (Editors) (2022), Conservation through Sustainable Use: Lessons from India. Routledge.
2. William P. Cunningham and Mary Ann Cunningham (2020), Principles of Environmental Science: Inquiry & Applications, 9th Edition, McGraw-Hill Education, USA.

<table>
<tr><td>ourse Code:
CSS2280</td><td colspan="3">Course Title: C Programming and Data Structures
Type of Course: 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">2.0</td></tr>
<tr><td>Course Prerequisites</td><td colspan="8">CSE1004 Problem Solving using C</td></tr>
<tr><td>Anti-requisites</td><td colspan="8">NIL</td></tr>
<tr><td>Course Description</td><td colspan="8">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 from C such as data types, control structures, arrays, pointers, dynamic memory management, and structures. Various data structures such as arrays, linked lists, stacks, queues, trees and graphs with sorting and searching algorithms are also covered. An application of these data structures is AI are also covered at conceptual level.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of this course is to equip learners with a comprehensive understanding of the fundamental data structures using C. 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 and AI applications effectively. This course aims to develop strong problem-solving skills and a foundation for further studies in computer science.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of the course the students shall be able to:
C.O.1: Explain the various programming constructs of C [Understand]
C.O.2: Implement various linear data structures like arrays, linked lists, stacks, and queues using C to solve specific problems. [Apply]
C.O.3: Apply non-linear data structures such as binary trees and graphs in problem solving [Apply]
C.O.4: Implement different sorting and searching algorithms in C for efficient data manipulation. [Apply]
C.O.5: Explain the role of various data structures in AI applications. [Understand]</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>C Programming Constructs</td><td>Assignment – Implementation</td><td colspan="2"></td><td colspan="4">12 Sessions</td></tr>
<tr><td colspan="9">Topics:
Data Types, Variables, Operators, Expressions and Statements: Conditional and loops, Arrays, Pointers, Dynamic memory management, Structures – array of structures, structure pointers, Functions: call by value, call by reference, functions with pointers and functions with structures, recursive functions.</td></tr>
</table>

Module 2	Linear Data Structures	Assignment		12 Sessions
Topics: Stack -implementation and applications – infix to postfix, expression evaluation, Queue - implementation, applications, intro to Priority Queues, circular queues. Linked list : Singly, Doubly-Linked Lists, Circular Linked List, applications				
Module 3	Non-Linear Data Structures	Assignment		8 Sessions
Topics: Trees, Binary Trees, Tree Traversals, Expression Trees, Binary Search Tree, Graphs: types, representation-adjaceny matrix/list, traversals, algorithms, applications				
Module 4	Searching and Sorting	Assignment		8 Sessions
Topics: Searching : Linear Search, Binary Search, Hash search - Hash Functions, Separate Chaining, Open Addressing, Linear Probing, Intro - Quadratic Probing, Sorting: Insertion Sort, Quick Sort, Merge Sort				
Module 5	Data Structures and Algorithms in AI	Assignment		5 Sessions
Topics: Overview of AI, machine learning (ML), deep learning (DL) and reinforcement learning (RL) Role of arrays, matrices and tensors for efficient data management in AI, Applications of graphs in AI – knowledge graphs, social network analysis, path finding – using Dijkstra's algorithm, graph traversal algorithms in web crawlers Bloom filters and probabilistic data structures – intro, applications in recommendation systems, malware and bot detection.				
Targeted Application & Tools that can be used: Implementation of the concepts using Turbo-C/WSL – Windows subsystem for Linux/VS Code				
Text Book(s): T1: Kanetkar Y, "Let us C", 20th Ed, BPB Publications, 2024. T2: Kanetkar Y, "Data Structures through C", 4th Ed, BPB Publications, 2022. T3: Balaguruswamy E, "C Programming and Data Structures", 4th Ed, Tata McGraw-Hill, 2009.				
Reference(s): R1. A. A. Puntambekar , "C Programming and Data Structures for BE Anna University R21CBCS (III-ECE/EEE - CS3353)", Technical Publications, 2022. R2. Anshuman Mishra, "Data Structures and Algorithms for AI and ML", Asia Pacific, 2025. R3. Amitava Nag, Jyoti Prakash Singh, "Data Structures and Algorithms Using C", S. Chand Publishing, 2011. R3. B.K.Mathan Nagan and T.Mahalakshmi, "Programming in C and Data Structures", Charulatha Publications,2011. R4. Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures A pseudocode approach using C", Thomson Learning, 2005 **E-Resources/Web Resources** 1. EBook: https://presiuniv.knimbus.com/user#/home 2. https://onlinecourses.nptel.ac.in/noc22_cs40/preview 3. https://onlinecourses.swayam2.ac.in/nou23_cs13/preview				

4. https://opendsa-server.cs.vt.edu/ODSA/Books/vt/cs5040-3777c729-6b55-4f8d-8efd-548985c00deb/fall-2023/CS5040F23/html/index.html
5. Data Structures by Geeta TV, https://ebooks.inflibnet.ac.in/csp01/

<table>
<tr><td>Course Code:
CSS2281</td><td>Course Title: C Programming and Data Structure
Type of Course: Lab</td><td>L- T- P- C</td><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td>Version No.</td><td colspan="6">2.0</td></tr>
<tr><td>Course Prerequisites</td><td colspan="6">CSE1004 Problem Solving using C</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">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 from C such as data types, control structures, arrays, pointers, dynamic memory management, and structures. Various data structures such as arrays, linked lists, stacks, queues, trees and graphs with sorting and searching algorithms are also covered. An application of these data structures is AI are also covered at conceptual level.</td></tr>
<tr><td>Course Objective</td><td colspan="6">The objective of this course is to equip learners with a comprehensive understanding of the fundamental data structures using C. 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 and AI applications effectively. This course aims to develop strong problem-solving skills and a foundation for further studies in computer science.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of the course the students shall be able to:
C.O.1: Explain the various programming constructs of C [Understand]
C.O.2: Implement various linear data structures like arrays, linked lists, stacks, and queues using C to solve specific problems. [Apply]
C.O.3: Apply non-linear data structures such as binary trees and graphs in problem solving [Apply]
C.O.4: Implement different sorting and searching algorithms in C for efficient data manipulation. [Apply]
C.O.5: Apply the appropriate data structures in AI applications. [Apply]</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
</table>

Module 1	C Programming Constructs	Assignment – Implementation		8 Sessions

1. 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.
2. Write a C program to determine if a given integer is positive, negative, or zero using if-else statements.
3. 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.
4. Write a C program to print the first n natural numbers using a for loop.
5. Write a C program to calculate the factorial of a given number using a while loop.
6. Write a C program to calculate the area of a circle using a function that takes the radius as input.
7. Write a program to define swap(int a, int b) to swap the values of 'a' and 'b'. Demonstrate the program using call by value and call by reference.
8. Write a C program to define a function add (int a, int b, int *sum, int*diff) that returns the sum and difference of two integers. Call this function from the main function and display the result.
9. Write a C program to read 5 integer values into an array, find the sum and average of elements and display them.
10. Write a C program to manage employee records using dynamic memory allocation functions with Employee ID, Employee Name, and Salary of N employees. The program should read the number of employees (**N**) and use m**alloc()** to allocate memory for storing employee records. Accept and display the employee details. The program should then allow the user to add **M** additional employee records by resizing the existing memory using **realloc()**. After storing the new records, display all employee details, calculate and display the total salary expenditure, and identify the employee with the highest salary. Finally, release all dynamically allocated memory using **free()** before terminating the program.
11. Write a C program to create an array of structures to store book details. Pass this array to a function, which searches for a particular book given its id.
12. Write a C program to create a student structure and access its members using a structure pointer.
13. Write a C program that uses a **recursive function** to determine whether a given number is a palindrome.

Module 2	Linear Data Structures	Assignment		8 Sessions

14. Write a C program to implement a **Stack** using an array and perform push, pop, peek, and display operations.
15. Write a menu-driven C program to implement both a **Linear Queue** and a **Circular Queue** using arrays. The program should support insertion, deletion, display, and overflow/underflow handling.
16. Write a menu-driven C program to implement a **Singly Linked List** with the following operations:

- Create the list by appending nodes.
- Display the list.
- Insert at beginning and in a specific position
- Delete from beginning, end and specific position
- Search for an element

17. Write a C program to implement a **Doubly Linked List** with the following operations:

- Creating the list
- Display list

18. Write a C program to implement a **Circular Linked List** with the following operations:

- Creating the list
- Display list

Module 3	Non-Linear Data Structures	Assignment		6 Sessions

19. Write a C program to create a binary tree and perform **inorder, preorder, and postorder traversals**. The program should display the sequence of node values obtained through each traversal technique.
20. Write a C program to implement a **Binary Search Tree (BST)**. The program should allow insertion of nodes into the BST and provide an option to search for a specified key. Display an appropriate message indicating whether the key is found in the tree.
21. Write a C program to represent a graph using both **Adjacency Matrix** and **Adjacency List** representations. Implement **Breadth First Search (BFS)** and **Depth First Search (DFS)** traversals starting from a specified vertex and display the order of traversal.

Module 4	Searching and Sorting	Assignment		6 Sessions

22. Write a C program to implement linear search to find a given element in an array.
23. Write a C program to implement binary search to find a given element in a sorted array.
24. Write a C program to implement the insertion sort on a given array of integers.
25. Write a C program to implement the Quick sort algorithm on a given array of integers.
26. Write a C program to implement the Merge sort algorithm on a given array of integers.

27. Write a C program to implement a **Hash Table** using a suitable hash function and **Separate Chaining** collision resolution technique. The program should support the insertion of keys into the hash table and display the contents of the table after all insertions 28. Write a C program to perform **searching and deletion operations** on a Hash Table implemented using **Separate Chaining**. The program should allow the user to search for a given key, delete a specified key, and display the updated contents of the hash table.				
Module 5	**Data Structures and Algorithms in AI**	**Assignment**		**2 Sessions**
29. Write a C program to represent a weighted graph using an adjacency matrix and implement **Dijkstra's Algorithm** to find the shortest path from a given source vertex to all other vertices. Display the shortest distance and the corresponding path to each vertex. 30. Write a C program to implement a **Bloom Filter** using multiple hash functions. The program should support insertion of elements and membership queries, indicating whether an element is possibly present or definitely not present in the set.				
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: CSS1500	**Course Title: Computational Thinking using Python** **Type of Course: Lab Integrated 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 Objective	To develop computational thinking and problem-solving skills using Python by enabling students to design algorithms, implement programs using core programming constructs and build efficient solutions using data structures and file handling techniques for real-world applications.	
Course Outcomes	On successful completion of this course, students will be able to: **CO1:** Apply computational thinking principles to design algorithms for solving basic and intermediate computing problems. [Understand] **CO2:** Implement Python programs using data types, operators, and expressions to perform computational tasks. [Apply] **CO3:** Develop programs using control structures, functions, and recursion to solve structured problems. [Apply] **CO4:** Utilize data structures such as lists, tuples, and dictionaries for efficient data representation and manipulation. [Apply] **CO5:** Design and implement Python programs for file handling and exception management to handle real-world data. [Apply] **CO6:** Build modular and reusable programs using functions and standard Python libraries to enhance code efficiency and readability. [Apply]	
Course Content:		
Module 1	**Computational Thinking And Problem Solving**	**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**	**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**	**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	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	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).

List of Practical Tasks **30 Sessions**

WEEK 1: Computational Thinking & Algorithms

Lab Sheet 1: Problem Solving & Algorithm Design

Level 1: Write an algorithm and Python program to find the minimum element in a list of numbers.

Level 2: Write an algorithm and Python program to insert an element into a sorted list at the correct position.

Lab Sheet 2: Algorithm Strategies (Iteration & Recursion)

Level 1: Write a Python program to guess a number within a given range using iteration.

Level 2: Write a Python program to solve the Tower of Hanoi problem using recursion.

WEEK 2: Data Types & Expressions

Lab Sheet 3: Data Types & Variables

Level 1: Write a Python program to demonstrate different data types (int, float, boolean, string, list).

Level 2: Write a Python program to perform type conversions and display results.

Lab Sheet 4: Expressions & Operators

Level 1: Write a Python program to swap two variables using tuple assignment.

Level 2: Write a Python program to circulate the values of n variables.

WEEK 3: Expressions & Problem Solving

Lab Sheet 5: Mathematical Expressions

Level 1: Write a Python program to calculate the distance between two points.

Level 2: Write a Python program to evaluate complex arithmetic expressions with operator precedence.

Lab Sheet 6: Debugging & Interactive Mode

Level 1: Write a Python program with intentional errors and debug it.

Level 2: Write a Python program to demonstrate interactive mode operations.

WEEK 4: Conditional Statements

Lab Sheet 7: Decision Making

Level 1: Write a Python program to check whether a number is positive, negative, or zero.

Level 2: Write a Python program to find the largest of three numbers using if-elif-else.

Lab Sheet 8: Advanced Conditions

Level 1: Write a Python program to check whether a number is even or odd.

Level 2: Write a Python program to implement a grading system using chained conditions.

WEEK 5: Iteration (Loops)

Lab Sheet 9: Looping Basics

Level 1: Write a Python program to print numbers from 1 to N using a loop.

Level 2: Write a Python program to compute factorial using loops.

Lab Sheet 10: Loop Control

Level 1: Write a Python program demonstrating break and continue.

Level 2: Write a Python program to generate number patterns using nested loops.

WEEK 6: Functions

Lab Sheet 11: Functions Basics

Level 1: Write a Python function to calculate square root of a number.

Level 2: Write a Python function to find GCD of two numbers.

Lab Sheet 12: Recursion & Scope

Level 1: Write a recursive function to calculate exponentiation.

Level 2: Write a Python program demonstrating local and global variables.

WEEK 7: Strings

Lab Sheet 13: String Operations

Level 1: Write a Python program to demonstrate string slicing.

Level 2: Write a Python program to check whether a string is a palindrome.

Lab Sheet 14: String Methods

Level 1: Write a Python program using string functions (upper, lower, replace).

Level 2: Write a Python program to count vowels and consonants in a string.

WEEK 8: Lists

Lab Sheet 15: List Basics

Level 1: Write a Python program to create and display a list.

Level 2: Write a Python program to find the sum of elements in a list.

Lab Sheet 16: List Operations

Level 1: Write a Python program to demonstrate list slicing.

Level 2: Write a Python program to perform linear search on a list.

WEEK 9: Advanced Lists

Lab Sheet 17: List Methods

Level 1: Write a Python program to demonstrate list methods (append, remove).

Level 2: Write a Python program to sort a list.

Lab Sheet 18: List Comprehension

Level 1: Write a Python program using list comprehension to generate squares.

Level 2: Write a Python program to create a histogram of list values.

WEEK 10: Tuples

Lab Sheet 19: Tuple Basics

Level 1: Write a Python program to create and access tuple elements.

Level 2: Write a Python program to demonstrate tuple assignment.

Lab Sheet 20: Tuples as Return Values

Level 1: Write a Python function returning multiple values using tuple.

Level 2: Write a Python program to swap values using tuples.

WEEK 11: Dictionaries

Lab Sheet 21: Dictionary Basics

Level 1: Write a Python program to create and access dictionary elements.

Level 2: Write a Python program to count frequency of elements using dictionary.

Lab Sheet 22: Dictionary Applications

Level 1: Write a Python program to store student marks using dictionary.

Level 2: Write a Python program to generate a retail bill using dictionary.

WEEK 12: Advanced List Processing

Lab Sheet 23: Sorting & Searching

Level 1: Write a Python program to implement simple sorting.

Level 2: Write a Python program to implement binary search.

Lab Sheet 24: Data Processing

Level 1: Write a Python program to generate student marks statement.

Level 2: Write a Python program to analyze list data (min, max, average).

WEEK 13: File Handling Basics

Lab Sheet 25: File Operations

Level 1: Write a Python program to create and write to a text file.

Level 2: Write a Python program to read and display file contents.

Lab Sheet 26: File Processing

Level 1: Write a Python program to count words in a file.

Level 2: Write a Python program to copy contents from one file to another.

WEEK 14: Exceptions & Validation

Lab Sheet 27: Exception Handling

Level 1: Write a Python program using try-except.

Level 2: Write a Python program to handle multiple exceptions.

Lab Sheet 28: Validation Programs

Level 1: Write a Python program to validate voter's age.

Level 2: Write a Python program to validate marks range (0–100).

WEEK 15: Modules & Advanced Concepts

Lab Sheet 29: Modules & Packages

Level 1: Write a Python program to create and use a module.

Level 2: Write a Python program to use built-in modules.

Lab Sheet 30: Command Line Arguments

Level 1: Write a Python program to accept command-line arguments.

Level 2: Write a Python program to perform operations using command-line inputs

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

1. **Topics relevant to development of "Employability":** Data structures using python.
2. **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: CO1 : Apply network reduction techniques and source transformations to simplify electric circuits. CO2: Compute electrical circuit parameters by applying suitable network theorems. CO3: Interpret the transient behavior of RL and RC circuits using differential equations and Laplace transform techniques. CO4: Analyze the frequency response and resonance characteristics of RL and RC circuits. CO5: Determine the parameters of two-port networks (Z, Y, h, ABCD) and their interrelationships. CO6: Calculate voltage, current, and power relations in balanced and unbalanced polyphase 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.				
	Module:4			

Module4	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 Applications and Tools

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", Mcgraw Hill company,2009
2. Charles K Alexander and Matthew NO Sadiku "Fundamentals of Electric Circuits (4^{th}) 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&query Text=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	21^{st} BoS, Held on 09/06/2025
Date of Approval by the Academic Council	18^{th} Academic Council Meeting, dated on 3/8/2022

Course Code: ECE2023	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	EEE1200 - Basics of Electrical and Electronics Engineering					
Anti-requisites	NIL					

<table>
<tr><td>Course Description</td><td colspan="4">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 courses 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. The course also enhances the Design, Implementation and Programming abilities through laboratory assignments. The associated laboratory provides an opportunity to certify the theoretic knowledge.</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of Digital Electronics and attain SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of the course the students shall be able to:
CO1: Explain the concept of number system, conversion, Boolean laws and logic gates. (L2)
CO2: Implement simplified Boolean functions using Karnaugh maps and universal gates. (L3)
CO3: Design combinational circuits for the given real time application. (L3)
CO4: explain the principles of modeling combinational circuits using Hardware Description Languages (HDLs). (L2)
CO5: Design synchronous sequential circuits such as counters and shift registers using appropriate flip flops . (L3)
CO6: explain the principles of modeling sequential circuits using Hardware Description Languages (HDLs). (L2)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Fundamentals of Number systems- Boolean algebra and digital logic</td><td>Application Assignment</td><td>Data Analysis task</td><td>10 classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Boolean function simplification</td><td>Application Assignment</td><td>Data Analysis task</td><td>9 Classes</td></tr>
<tr><td colspan="5">Introduction, two variable, three variable, four variable K-Map - Don’t care conditions. Quine–McCluskey minimization techniques. NAND & NOR Implementation.</td></tr>
<tr><td>Module 3</td><td>Combinational Logic circuits:</td><td>Application Assignment</td><td>Programming Task & Data Analysis task</td><td>13 Classes</td></tr>
<tr><td colspan="5">Introduction to Combinational circuits, Analysis, Design procedure, Binary Adder and Subtractor, Magnitude comparator, Multiplexers-De-multiplexers, Encoders - Decoders, Architecture and implementation of Boolean functions using ROM, PLA and PAL. HDL Models of combinational circuits.</td></tr>
<tr><td>Module 4</td><td>Sequential and Programmable logic circuits:</td><td>Application Assignment</td><td>Programming Task & Data Analysis task</td><td>13 Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">Text Book(s):
1. Mano, M. Morris and Ciletti Michael D., “Digital Design”, Pearson Education, 6th edition, 2018.
2. Thomas L. Floyd “Digital Fundamentals”, Pearson Education, 11th edition, 2018.</td></tr>
<tr><td colspan="5">Reference(s):
Reference Book(s):</td></tr>
</table>

R1. Jain, R. P. and Sarawadeka, Kishor *"Modern Digital Electronics"*, McGraw Hill Education (India), 5th Edition, 2022.

R2. Roth, Charles H., Jr and Kinney Larry L., *"Fundamentals of logic Design"*, Cengage Learning, 7th Edition, 2021.

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

1. EBook: https://presiuniv.knimbus.com/user#/home
2. Course Website: https://ece2023-de.netlify.app/
3. NPTEL COURSE ON : Digital Electronic Circuits, IIT Kharagpur, https://nptel.ac.in/courses/108105132
4. NPTEL COURSE ON : Introduction To Digital Circuits, https://nptel.ac.in/courses/117106086
5. NPTEL COURSE ON : Digital Circuits and Systems, IIT Madras, https://nptel.ac.in/courses/117106114
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

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	EEE1200 - Basics of Electrical and Electronics Engineering					
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 courses 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 combinational as well as sequential Digital Logic Circuits. The course also enhances the Design, Implementation and Programming abilities through laboratory assignments. The associated laboratory provides an opportunity to certify the theoretic knowledge.					
Course Objective	The objective of the course is 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 principles of logic gates and Boolean algebra using standard digital ICs. (L2) CO2: Implement Adders and Subtractors using digital ICs. (L3) CO3: Realize combinational logic circuits for customized specifications. (L3) CO4: Design Counters and Shift Registers using flip-flops. (L3) CO5: Construct combinational logic circuits using Electronic Design Automation tools. (L3) CO6: Simulate sequential logic circuits using Electronic Design Automation tools. (L3)					
Course Content:						

Experiment 1:Verify the Logic Gates truth table
Level 1: By using Digital Logic Trainer kit
Level 2: By using Universal logic gates and Trainer Kit

Experiment 2:Verify the Boolean Function and Rules by using Digital Logic Trainer kit

Experiment 3: 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 4:Design and Implementations of Half Adder/Full Adder
Level 1: By using basic logic gates and Trainer Kit
Level 2: By using Universal logic gates and Trainer Kit

Experiment 5:Design and Implementations of Half Subtractor/Full Subtractor
Level 1: By using basic logic gates and Trainer Kit
Level 2: By using Universal logic gates and Trainer Kit

Experiment 6:Study of Flip flops – SR, D, JK, T

Experiment 7: Design and Implementations of THREE bit up counter/Down counter synchronous counter using JK flipflop

Experiment 8: Design and implementation of 4 bit Shift registers using D-Flip Flop - SISO, & PIPO

Experiment 9: HDL coding for basic combinational logic circuit
Level 1: Gate level Modeling
Level 2: Behavioral Modeling

Experiment 10: HDL coding for basic sequential logic circuit
Level 1: Gate level Modeling
Level 2: Behavioral Modeling

Targeted Applications and Tools that can be used:

Application Area	Hands-on Application Problem	Tools & Techniques	Relevant Industry
Basic Digital Circuit Verification	Verification of logic gate truth tables; Boolean function and theorem validation	Digital Logic Trainer Kit, Discrete Components, ICs	Electronics Manufacturing, Embedded Systems
Arithmetic Circuit Design	Design and implementation of half/full adders and subtractors	Basic Gates, Universal Gates, Breadboard Prototyping	Consumer Electronics, Digital Hardware Design
Combinational Logic Implementation	Realization of logic from given specifications; Code converters (BCD to Excess-3, Gray to Binary)	Truth Table Design, Logic Simulation (HDL), Circuit Implementation	Automation, Instrumentation
Sequential Logic Development	Study and implementation of flip-flops; Design of synchronous counters	Waveform Analysis Tools, IC-based Circuits, HDL Simulation	Digital Systems, Robotics

Skill Development Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Boolean Function Implementation	Design logic gates and reduce expressions	Breadboard, ICs, Logic Gates	Digital logic building, truth table mapping
Flip-Flop Operation Study	Test SR, JK, T flip-flops	Breadboard, Timer ICs	Sequential logic behavior
Counters and Shift Register Demo	Design binary counters and shift registers	IC 7490, 74194	Digital timing circuits, bit manipulation

Text Book(s):

1. Mano, M. Morris and Ciletti Michael D., "Digital Design", Pearson Education, Sixth edition, 2018

Reference(s):

Reference Book(s):

1. Jain, R. P., "Modern Digital Electronics", McGraw Hill Education (India), Fourth Edition
2. Roth, Charles H., Jr and Kinney Larry L., "Fundamentals of logic Design", Cengage Learning, Seventh Edition

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

7. EBook: https://presiuniv.knimbus.com/user#/home
8. Course Website: https://ece2023-de.netlify.app/
9. NPTEL COURSE ON : Digital Electronic Circuits, IIT Kharagpur, https://nptel.ac.in/courses/108105132
10. NPTEL COURSE ON : Introduction To Digital Circuits, https://nptel.ac.in/courses/117106086
11. NPTEL COURSE ON : Digital Circuits and Systems, IIT Madras, https://nptel.ac.in/courses/117106114
12. Lab Tutorial: Multisim Tutorial for Digital Circuits - Bing video
    CircuitVerse - Digital Circuit Simulator online
    Learn Logisim➠ Beginners Tutorial | Easy Explanation! - Bing video
    Digital Design 5: LOGISIM Tutorial & Demo

E-content:

1. Z. Xin-Li and W. Hong-Ying, "The application of digital electronics in networking communication," in *Proc. 8th Int. Conf. Measuring Technology and Mechatronics Automation (ICMTMA)*, 2016, pp. 684-687, doi: 10.1109/ICMTMA.2016.168.
2. D. Bhadra, T. A. Tarique, S. U. Ahmed, M. Shahjahan, and K. Murase, "An encoding technique for design and optimization of combinational logic circuits," in *Proc. 13th Int. Conf. Computer and Information Technology (ICCIT)*, 2010.
3. A. Matrosova and V. Provkin, "Applying incompletely specified Boolean functions for patch circuit generation," in *Proc. 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," in *Proc. 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 held on 07/01/2026
Date of Approval by the Academic Council	Academic Council Meeting, Dated 07/01/2026

<table>
<tr><td>Course Code:
ECE2508</td><td colspan="3">Course Title: Signal Processing
Type of Course: Program Core-Theory</td><td>L-T-P-C</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Version No.</td><td colspan="8">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="8">An understanding in basic concepts of electronic circuits and familiarity with discrete mathematics.</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 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.</td></tr>
<tr><td>Course Objective</td><td colspan="8">The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On successful completion of this course the students shall be able to:
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:Determine the transfer functions of analog Butterworth filters and implement their digital IIR equivalents using impulse invariance and bilinear transformation methods.
CO5:Sketch the realization structures for IIR filters, including Direct Form I, Direct Form II, Cascade, and Parallel, from given transfer functions.
CO6:Analyze the performance of FIR filters implemented with Rectangular, Hamming, and Hanning window techniques through their magnitude response characteristics.</td></tr>
<tr><td>Course Content:</td><td colspan="8"></td></tr>
<tr><td>Module 1</td><td>Overview of Signals and Systems</td><td>Assignment / Quiz</td><td colspan="3">Memory Recall based Quizzes/ Problem Solving Tutorial</td><td colspan="3">12 session</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>Module 2</td><td>Discrete Fourier Transform</td><td>Assignment / Quiz</td><td colspan="3">Memory Recall based Quizzes/ Problem Solving Tutorial</td><td colspan="3">12 session</td></tr>
</table>

<table>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 3</td><td>IIR Filter Design and Realizations</td><td>Assignment / Quiz</td><td>Memory Recall based Quizzes/ Problem Solving Tutorial</td><td>12 session</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 4</td><td>FIR Filter Design and Realizations</td><td>Assignment / Quiz</td><td>Memory Recall based Quizzes/ Problem Solving Tutorial</td><td>12 session</td></tr>
<tr><td colspan="5">FIR filter design using windows (Rectangular/Hamming/ Hanning window), Frequency sampling method. FIR filter structures - direct form realizations - linear phase structure realizations.</td></tr>
<tr><td>Module 5</td><td>Finite word length effects and Processor Fundamentals</td><td>Assignment / Quiz</td><td>Memory Recall based Quizzes/ Problem Solving Tutorial</td><td>12 session</td></tr>
<tr><td colspan="5">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</td></tr>
</table>

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: ECE2558	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 to <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Apply MATLAB programming to generate and manipulate basic CT and DT signals through operations like scaling, shifting, and inversion. CO2: Analyze circular convolution and DFT/IDFT computations in MATLAB by comparing theoretical expectations with simulated results. CO3: Compare Butterworth IIR and FIR filters (using different windows) in MATLAB, evaluating their frequency responses against given specifications.					

	CO4: Examine impulse response and pole-zero plots of difference equations to interpret system stability and frequency characteristics. CO5: Demonstrate circular convolution and DFT-based filtering on a DSP processor using CCS (Code Composer Studio) and compare results with MATLAB simulations. CO6: Illustrate practical limitations of DSP algorithms by contrasting software (MATLAB) simulations with hardware (DSP Kit) implementations.
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:
ECE2517</td><td colspan="2">Course Title: Communication Systems
Type of Course: 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="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">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</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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</td></tr>
<tr><td>Course Objective</td><td colspan="7">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:
CO1 Explain the fundamental concepts of amplitude modulation and demodulation characteristics.
CO2 Find the modulation index, bandwidth and total power in analog communication systems using amplitude modulation and demodulation techniques for AM signals.
CO3 Calculate the 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 address the problems in digital communication systems.
CO5 Describe the generation, properties, and applications of pseudo-noise 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.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Introduction to Communication Engineering</td><td>Assignment</td><td colspan="2">Simulation task</td><td colspan="3">12classes</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 2</td><td>Angle modulation and demodulation</td><td>Case Study</td><td colspan="2">Simulation task.</td><td colspan="3">12 classes</td></tr>
<tr><td colspan="8">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.</td></tr>
</table>

<table>
<tr><td>Module 3</td><td>Digital Modulation Techniques</td><td>Assignment</td><td>Simulation task :</td><td>12 classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 4</td><td>Spread Spectrum Modulation and Detection & Estimation</td><td>Assignment</td><td>Simulation task:.</td><td>09 classes</td></tr>
<tr><td colspan="5">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.</td></tr>
</table>

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: Laboratory only	L-T-P-C	0	0	2	1
Version No.	1.0					
Course Pre-requisites	No prerequisites					
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 EXPERIENTIAL 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)					
List of Laboratory Tasks:						

Experiment N0.1: Study and implementation of amplitude modulation and demodulation
Level-1: To study and implement amplitude modulation and demodulation using an experimental setup.
Level-2: To study, simulate and implement amplitude modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.2: Study and implementation of AM-DSB-SC modulation and demodulation
Level-1: To study and implement AM-DSB-SC modulation and demodulation using an experimental setup.
Level-2: To study, simulate and implement AM-DSB-SC modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.3: Study and implementation of AM-SSB-SC modulation and demodulation
Level-1: To study and implement AM-SSB-SC modulation and demodulation using an experimental setup.

Level-2: To study, simulate and implement AM-SSB-SC modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.4: Study and implementation of frequency modulation and demodulation
Level-1: o study and implement frequency modulation and demodulation using an experimental setup.
Level-2: To study, simulate and implement frequency modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.5: Study and implementation of Frequency Division Multiplexing (FDM) with DSB-SC modulation and demodulation
Level-1: To study and implement Frequency Division Multiplexing (FDM) with Double Sideband Suppressed Carrier (DSB-SC) modulation and demodulation using an experimental setup.
Level-2: To study, simulate and implement Frequency Division Multiplexing (FDM) with DSB-SC modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.6: Study and implementation of pulse amplitude modulation and demodulation
Level-1: To study and implement pulse amplitude modulation and demodulation using an experimental setup.
Level-2: To study, simulate and implement pulse amplitude modulation and demodulation using software tools, and to calculate key performance parameters.

Experiment N0.7: Study and implementation of sampling and reconstruction circuit
Level-1: To study and implement a sampling and reconstruction circuit to convert a given analog signal into its samples with a sampling frequency $fs \geq 2fmax$, and to reconstruct the original signal using an experimental setup.
Level-2: To study, simulate and implement a sampling and reconstruction circuit to convert a given analog signal into its samples with a sampling frequency $fs \geq 2fmax$, and to reconstruct the original signal using software tools.

Experiment No.8: Study and implementation of Amplitude Shift Keying (ASK) modulation and demodulation
Level-1: To study and implement circuits for modulation and demodulation of Amplitude Shift Keying (ASK) for a given binary data stream using an experimental setup.
Level-2: To study, simulate and implement circuits for modulation and demodulation of Amplitude Shift Keying (ASK) for a given binary data stream using software tools.

Experiment No.9: Study and implementation of Frequency Shift Keying (FSK) modulation and demodulation
Level-1: To study and implement circuits to verify the modulation and demodulation of Frequency Shift Keying (FSK) for a given binary data stream using an experimental setup.
Level-2: To study, simulate and implement circuits to verify the modulation and demodulation of Frequency Shift Keying (FSK) for a given binary data stream using software tools.

Experiment No.10: Study and implementation of Time Division Multiplexing (TDM)
Level-1: To study and implement Time Division Multiplexing (TDM) of four band-limited signals using an experimental setup, and to verify multiplexed transmission through a single communication channel experimentally.
Level-2: To study, simulate and implement Time Division Multiplexing (TDM) of four band-limited signals using software tools, and to verify multiplexed transmission of different signals in distinct time slots over a single channel.

Experiment No.11: Study and implementation of Pulse Code Modulation (PCM) and Demodulation

Level-1: To study and implement Pulse Code Modulation (PCM) and demodulation using an experimental setup to encode an analog signal into binary bits and reconstruct the original signal experimentally.
Level-2: To study, simulate and implement Pulse Code Modulation (PCM) and demodulation using software tools for encoding a given analog signal into binary data and reconstructing the signal via simulation.

Experiment No.12: Study and implementation of Delta Modulation and Demodulation
Level-1: To study and implement Delta modulation and demodulation using an experimental setup, analyzing the comparison of current and previous samples of the modulating signal experimentally.
Level-2: To study, simulate and implement Delta modulation and demodulation using software tools, by comparing current and previous samples of the modulating signal through simulation.

Targeted Application & Tools that can be used:

Application: 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):

T1: Simon Haykin, "Communication Systems", John Wiley Publication, 2009, 5th Edition.
T2: B.P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press 2011, 4th Edition.

Reference(s):

Reference Book(s):

R1: B. Sklar, "Digital Communication: Fundamentals and Applications", Pearson Edition, 2nd Edition.
R2: Sam Shanmugam, "Digital & Analog Communication K.", John Wiley Publication, 2nd Edition.
R3: 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/

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. Practical/Laboratory Resources: 1. Communication Systems Laboratory Manual, Presidency University, Bengaluru.
Topics relevant to "SKILL DEVELOPMENT": Sampling, Analog and Digital Modulation Techniques for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr. Natya.S
Recommended by the Board of Studies on	21st BOS held on 9th June 2025
Date of Approval by the Academic Council	26th Academic Council Meeting held on 25th July 2025

Course Code: **FIN1005**	**Course Title: Finance Essentials for Decision Making** **Type of Course: HSMC**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Nil					
Anti-requisites						
Course Description	This course is designed to provide non-commerce students with a fundamental understanding of finance and its applications in personal and professional contexts. It introduces students to the basic concepts of finance, financial decision-making, and the financial environment, including markets and institutions. The course also develops the ability to read and interpret basic financial statements, understand the concepts of risk and return, and apply time value of money principles to simple investment decisions. Special emphasis is placed on personal finance, financial literacy, and digital finance to enable students to make informed financial decisions in everyday life.					
Course Objective	Upon successful completion of this course, students will be able to:					

	1. Understand fundamental concepts, areas, and functions of finance. 2. Explain the role of financial markets, institutions, and banks in the economy. 3. Interpret basic financial statements for simple decision-making. 4. Apply time value of money concepts to evaluate investment alternatives. 5. Understand the relationship between risk and return in financial decisions. 6. Develop financial literacy skills for effective personal financial management.			
Course Outcomes	**On successful completion of this course the students shall be able to:** CO.1 **Explain the basic concepts of finance, finance functions, and the financial environment.** CO.2 **Use financial information for business decision making.** CO.3 **Apply time value of money techniques and investment appraisal methods to evaluate simple investment proposals.** CO.4 **Analyze personal finance choices related to savings, investments, insurance, and retirement planning.**			
Course Content:				
Module 1	**Fundamentals of Finance and Financial Environment**	Assignment/ Quiz	Case study	**8 Sessions**
Topics: Meaning and importance of finance; Areas of finance: Personal, Corporate, and Public finance; Finance decisions; Finance functions; Forms of business organizations and basic financial implications; Goals of financial management: profit maximization vs. wealth maximization; Overview and types of financial markets: money market and capital market, Primary vs. Secondary Markets; Role of banks and financial institutions. Basic understanding taxes and its types.				
Module 2	**Financial Statements, Risk and Return**	Assignment/ Quiz	Numerical solving Task	**12 Sessions**
Topics: Purpose and importance of financial statements; Meaning of capital, assets, liabilities, income, and expenses; Basic financial statements: Income Statement; Balance Sheet (simple numerical); Introduction to ratio analysis: liquidity, profitability, solvency (basic level); Concept of return; Concept of risk: meaning and types; Risk–return relationship and diversification (conceptual).				
Module 3	**Time Value of Money and Investment Decisions**	Assignment/ Quiz	Numerical solving Task	**14 Sessions**
Topics: Concept and significance of time value of money; Future value and present value (single and multiple periods); Compounding and discounting (simple numerical); Doubling Period. Investment appraisal techniques: Payback Period, Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR); Introduction to cost of capital (conceptual): Equity, Debt, WACC.				
Module 4	**Personal Finance**	Assignment/ Quiz	Numerical solving Task	**11 Sessions**
Topics: Personal finance concepts: Budgeting and savings; Investment avenues: FDs, mutual funds, shares, bonds; Risk profiling and asset allocation; Insurance and retirement planning.				
Targeted Application & Tools that can be used: Spreadsheet software (Microsoft Excel / Google Sheets) for numerical problem-solving, Financial calculators (physical or mobile apps), Case studies and real-life financial scenarios, RBI and SEBI investor awareness materials, Online EMI, SIP, and retirement calculators, PPTs and visual financial models				
Project Work/ Assignment:				

1. **Case Study Analysis:** Analysis of a simple business or personal finance case involving budgeting, investment choice, or loan decision. 2. **Numerical Assignment:** Problems on time value of money, investment appraisal (NPV, Payback, IRR), and ratio analysis. 3. **Group Presentation:** Topics related to financial markets, investment avenues, or financial decision-making in real-life professions.
Text Book(s): 1. **Chandra, P.** – *Financial Management*, McGraw-Hill Education. 2. **Madura, J.** – *Personal Finance*, Pearson Education.
Reference Book (s): 1. **Khan, M. Y. & Jain, P. K.** – *Financial Management*, McGraw-Hill Education (Selected Chapters). 2. **Bhole, L.M., & Mahakud, J.** (Current Edition). *Financial Institutions and Markets: Structure, Growth and Innovations*. McGraw Hill Education India. 3. **Mehrotra, H.C., & Goyal, S.P.** (Latest Assessment Year Edition). *Income Tax Law & Practice*. Sahitya Bhawan Publications. 4. **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.rbi.org.in 4. https://www.sebi.gov.in/
Topics relevant to "SKILL DEVELOPMENT": This course contributes to skill development by enabling students to: Perform **basic financial calculations** (interest, returns, NPV, Payback), Interpret **financial statements** for informed decision-making' Develop **budgeting and savings discipline,** Evaluate **investment options** based on risk and return, Use **digital financial tools** for personal finance planning, Enhance **analytical thinking and problem-solving skills,** Improve **financial literacy and decision-making confidence** for professional and personal life.

Catalogue prepared by	**Dr. Yusaf Harun K**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: **ECE2509**	**Course Title: Solid State Electronics** **Type of Course: Program Core**	**L- T-P- C**	**3**	**0**	**0**	**3**
Version No.	**1.0**					
Course Pre-requisites	**Optoelectronics and Device Physics**					

Anti-requisites	**NIL**			
Course Description	This course introduces the fundamental physics and operating principles of semiconductor materials and devices used in modern electronic systems. It covers energy band theory, carrier transport, p–n junctions and diodes, bipolar junction transistors, and field effect transistors, with emphasis on linking material properties to device characteristics and circuit behaviour. The course equips students with a strong conceptual foundation to analyse existing semiconductor devices and to understand and adapt to emerging electronic device technologies and applications.			
Course Objective	**The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques.**			
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Explain the atomic structure, energy band formation, and charge carriers in semiconductors CO2: Describe carrier transport phenomena in semiconductors CO3: Apply semiconductor junction principles to analyse the operation and characteristics of p–n junction diodes CO4: Implement bipolar junction transistor principles to analyze device characteristics and behavior. CO5: Use field-effect transistor principles to analyse the characteristics and behaviour of JFETs and MOSFETs CO6: Analyze the operating principles and characteristics of special and advanced semiconductor devices CO7: Interpret semiconductor material properties and device characteristics using AI-assisted models			
Course Content:				
Module 1	**Semiconductor Physics and Transport**			**12 classes**
Atomic structure, Bonding Forces and Energy Bands in Solids, Direct and Indirect Semiconductors, Intrinsic and extrinsic semiconductors, Electrons and holes in semiconductors, Fermi level concept, Equilibrium carrier concentration, Charge neutrality condition, Temperature Dependence of Carrier Concentrations, Conductivity and Mobility, Current density and electric field, Diffusion and Drift of Carriers, Einstein relation, The Hall Effect, Excess Carriers in Semiconductors, Generation and Recombination of carriers, Carrier Lifetime, The Continuity Equation, Diffusion Length.				
Module 2	**Junctions and Semiconductor Diodes**			**10 classes**
Formation of p–n junction, Charge at Junction, Contact Potential, Energy band diagrams of p–n junction, Ideal diode equation, I–V characteristics, Effect of temperature, Capacitance of p-n Junctions, Recombination and Generation, Reverse-Bias Breakdown, Metal– Semiconductor Junctions, Schottky diode, Zener diode, Varactor Diode, PIN diodes, Tunnel Diode.				
Module 3	**Bipolar Junction Transistors**			**09 Classes**

BJT structure, Fundamentals of BJT Operation, NPN and PNP transistors, Modes of operation, Minority Carrier Distributions and Terminal Currents, Current gains, Input and output characteristics, Amplification with BJTs, Base width Narrowing, Punch-through, Gummel–Poon Model, Kirk Effect; Frequency Limitations of Transistors, Heterojunction Bipolar Transistors.

Module 4	**Field-Effect Transistors**			**10 Classes**

Basic concept of Field Effect Transistors, Junction FET, structure, operation and characteristics, Pinch-off and saturation in JFET, GaAs MESFET, Metal–Oxide–Semiconductor (MOS) structure, MOS capacitor, MOSFET structure and operation, Output Characteristics, Transfer Characteristics, Mobility Models, MOSFET I–V Characteristics, Threshold Voltage Expression, Channel length modulation, Substrate Bias Effects, Subthreshold Characteristics, CMOS processes, High Electron Mobility Transistor (HEMT)

Module 5	**AI-Assisted modelling of Semiconductor Devices**			**04 Classes**

AI in Solid State Electronics, Data-Driven Prediction of Semiconductor Material Properties, AI-Assisted Modelling of Transport and Junction Devices, Machine Learning for Diode and BJT Characterization, AI-Based Analysis of MOSFET Characteristics

Targeted Application & Tools that can be used:

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

Professionally Used Software: SPICE modelling/ Multisim/ LT spice, Python, TensorFlow/Keras, Pandas/Numpy/sklearn, Google Colab/Jupyter Notebook,

Project work/Assignment:

1. Book/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. 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. Students will present on emerging semiconductor devices.

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

Textbook(s):

1. Robert F. Pierret, "Semiconductor Device Fundamentals", Addison-Wesley Publishing Company, 1996

2. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014

References:

1. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006

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

E-Content:

1. Fei, A. (2024). A review of the development of transistor technology and its application in electronic devices. Applied and Computational Engineering, 56, 141-145. 2. Maadi, Mohammad. Evaluation of SPICE P-N Junction's, BJT's and MOSFET's Model Parameters. 3. Cao, W., Bu, H., Vinet, M. et al. (2023) The future transistors. Nature 620, 501–515. 4. Li, X., Wu, Z., et al. (2024) Overview of emerging semiconductor device model methodologies: From device physics to machine learning engines, 5, 2149-2160 5. https://nptel.ac.in/courses/117106091 6. https://nptel.ac.in/courses/115105099
Topics related to development of “FOUNDATION”: Energy band theory, Charge carriers in semiconductors, Drift and Diffusion of charge carriers, Mobility, conductivity, current density, and electric field, Excess carriers, Carrier lifetime, Continuity equation, p-n junctions, Energy band under equilibrium and bias, MOS Capacitor, BJT and MOSFET structure and operation Topics related to development of “EMPLOYABILITY”: Zener diode, Schottky diode, PIN diode, Varactor diode, HBT, HEMT, I-V characteristics of p-n junction diode, BJT and MOSFET, CMOS process.

Catalogue prepared by	**Dr. Noel Prashant Ratchagar**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code:
ECE2512</td><td colspan="2">Course Title: Microelectronics
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="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">Basic concepts of Digital and analog circuits.</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 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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">This course is designed to improve the learner's <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course, the students shall be able to:
CO1:Summarize the basics of MOSFET characteristics for single stage Amplifier.
CO2:Employ OP-AMP circuits to realize basic arithmetic operations
CO3:Design non-linear OP-AMP circuits to generate square and triangular waveforms.
CO4:Construct Low-Pass and High-Pass filter circuits to obtain their performance characteristics.
CO5:Develop circuits using different A/D and D/A converters and obtain their performance characteristics.
CO6:Examine the circuits of feedback networks and sinusoidal oscillators.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>MOSFETS</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">12 session</td></tr>
<tr><td colspan="8">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 SD amplifiers, Current mirrors and Current steering circuits,</td></tr>
<tr><td>Module 2</td><td>Opamp</td><td>Assignment / Quiz</td><td colspan="3">Programming task</td><td colspan="2">12 session</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 3</td><td>Non Linear Applications of op-amp</td><td>Assignment</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">9 session</td></tr>
<tr><td colspan="8">Topics:
Comparators, Zero crossing detector, Schmitt trigger circuit. Square and Triangular waveform generators, IC 555 timer - Monostable Multivibrator, Astable Multivibrator. Filters – Low pass filter</td></tr>
</table>

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,

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):

1. Razavi, Behzad. Fundamentals of microelectronics. John Wiley & Sons, 2021.
2. 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:

1. The future of microelectronics. https://ieeexplore.ieee.org/document/658769
2. Technical and economical trends in microelectronics. https://ieeexplore.ieee.org/document/4430873

3. Microelectronics-journal. https://www.sciencedirect.com/journal/microelectronics-journal 4. 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 Dharmesh Kumar Srivastava
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: CO1:Construct inverting and non-inverting amplifiers using IC 741, verify gain, and avoid saturation under varying input conditions conditions. CO2:Design inverting summing and difference amplifiers using IC 741, analyze output for mixed DC and AC inputs, and prevent saturation. CO3:Implement integrator and differentiator circuits using op-amps, analyze square wave responses, and relate RC time constants to signal periods. CO4:Evaluate frequency responses of active low-pass and high-pass filters, determine cutoff frequencies, and perform frequency scaling. CO5:Generate sinusoidal, square, and triangular waveforms using op-amp oscillators and measure oscillation frequency accurately. CO6:Implementation of Precision Rectifier for half wave and Full wave Rectifier.
Course Content:	

List of Laboratory Tasks:

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

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

Experiment No. 3: To setup a Difference amplifier circuit using OP-AMP 741 IC and observe the waveforms.
Level 1: Build the circuit of a Difference amplifier for the gain of 2 with the input signal of DC value of 1.5 V and the sinusoidal voltage of 1V p-p.
Level 2: Built the circuit to mix a sinusoidal signal and a dc signal without saturation for an amplification factor of 2.

Experiment No. 4: Build the circuit of Differentiator and Integrator and observe the waveforms.
Level 1: Build an integrator and a differentiator circuit using op-amp for a square wave input. Plot the output you obtained.

Level 2: In continuation with Level 1, determine the relation between the time period of the waveform and RC time constant of the circuit you have used. Plot the output obtained for different input frequencies.

Experiment No. 5: To obtain the frequency response of active low pass and high pass filters and determine 3dB frequencies of both filters.
Level 1: Plot the frequency response for the first order low-pass and high-pass filter with a cut-off frequency of 10kHz with a pass band gain of 1.5.
Level 2: In continuation with Level 1, analyze the circuit to achieve frequency scaling.

Experiment No. 6: Generation of sine, square and triangular waveform using op-amp.
Level 1: Construct a Wien bridge oscillator using op-amp 741 and (i) Plot the output waveform (ii) Measure the frequency of oscillation.
Level 2: Set up the frequency range in order to obtain triangular wave from square wave using Op-Amp 741 and plot the output waveform.

Experiment No. 7: To set up Schmitt Trigger circuit using IC 741.
Level 1: Setup square wave using IC 741, plot the output waveform.
Level 2: Setup square wave using IC 741 for t1 = 0.7ms.

Experiment No. 8: To set up analog output voltages for the digital input data using 4-bit R-2R ladder type D/A converter
Level 1: Study of 4 Bit R-2R Ladder.
Level 2: Obtain analog voltage from digital signal.

Experiment No. 9: To set up performance of Wein bridge and Phase shift Oscillator
Level 1: To study the Operation of Wein-Bridge Oscillator and RC Phase Shift Oscillator using IC 741.
Level 2: To determine the frequency of Oscillations

Experiment No. 10: To set up precision Half wave and Full Wave Rectifier using IC-741
Level 1: To study precision Half wave rectifier circuit using op-amp 741.
Level 2: To study precision Full wave rectifier circuit using op-amp 741.

Targeted Application & Tools that can be used:

Targeted Applications: Automotive technologies, personal electronics, consumer appliances etc. This course is useful for placement in core companies, research & development work.
Professionally Used Software: NI Multisim, LabVIEW, PSpice etc., device setup in laboratory.

Project Work/Assignment:

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):

3. Razavi, Behzad. Fundamentals of microelectronics. John Wiley & Sons, 2021.

4. 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:

5. The future of microelectronics. https://ieeexplore.ieee.org/document/658769
6. Technical and economical trends in microelectronics. https://ieeexplore.ieee.org/document/4430873
7. Microelectronics-journal. https://www.sciencedirect.com/journal/microelectronics-journal
8. 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 Dharmesh Kumar Srivastava
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: ECE2536	Course Title: Introduction to Fabrication Technology Type of Course: Program Core	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					

<table>
<tr><td>Course Description</td><td colspan="4">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="4">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="4">On successful completion of this course the students shall be able to:
1) Describe the process involved in crystal growth and the defects associated with it (L2)
2) Explain the processes to grow oxide on a semiconductor to obtain dielectrics and etch mask(L2)
3) Demonstrate lithography and etching techniques used for pattern transfer.(L3)
4) Use the diffusion and ion implantation mechanisms for doping a semiconductor.(L3)
5) Implementation physical vapor deposition and chemical vapor deposition techniques for Metallization and Insulation.(L3)
6) Summarize the process involved in packaging and yield for IC Fabrication.(L4)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Crystal Growth</td><td>Assignment</td><td>Memory Recall based Quizzes</td><td>10 Session</td></tr>
<tr><td colspan="5">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>Oxidation and lithography</td><td>Assignment</td><td>Theoretical Understanding</td><td>10 Session</td></tr>
<tr><td colspan="5">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>Diffusion and Thin Film Deposition</td><td>Assignment</td><td>Theoretical Understanding</td><td>12 Session</td></tr>
<tr><td colspan="5">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="5"></td></tr>
<tr><td>Module 4</td><td>IC Manufacturing:</td><td>Assignment</td><td>Theoretical Understanding</td><td>13 Session</td></tr>
<tr><td colspan="5">Topics:</td></tr>
</table>

IC Manufacturing: Electrical Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip. CMOS and BipolarJunction Transistor (BJT) fabrication steps, realization of on-chip resistor, diode, capacitor and inductor; Bonding and packaging
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 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":	Ms. ASHMITA MOIDU
Catalogue prepared by	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code: ECE2560</td><td>Course Title: Introduction to Fabrication Technology Lab
Type of Course: Program Core</td><td>L-T-P-C</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">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="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">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="6">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="6">On successful completion of this course the students shall be able to:

CO1:Explain cleanroom practices, safety protocols, and contamination control techniques used in semiconductor fabrication laboratories.

CO2:Perform wafer cleaning and preparation processes to ensure surface quality suitable for subsequent fabrication steps

CO3:Demonstrate oxidation and diffusion processes to analyze their impact on material properties and device performance

CO4:Analyze photolithography techniques for pattern transfer on silicon wafers.

CO5:Illustrate thin-film deposition processes to characterize deposited films in terms of thickness and uniformity.

CO6:Identify the fabrication process outcomes to improve performance of semiconductor devices.</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td colspan="7">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</td></tr>
</table>

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	ASHMITA MOIDU
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	ECE2020: 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. Develop the transfer function for any Electrical and Mechanical systems. 2. Apply Block diagram algebra and Mason's Gain Formula for the given Block diagram and Signal Flow Graph 3. Examine the time response of second order system for unit step input 4. Analyse the stability of the given system using time domain and frequency domain methods 5. Choose the suitable compensation network for the given system 6. Identify 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 Applications and Tools 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.

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

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: ECE2521	Course Title: Embedded System Design Using Microcontroller Type of Course: Theory	L-T-P-C	4	0	0	4
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 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.					
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: Explain the fundamental concepts of embedded systems, RISC philosophy, and processor architecture (ARM, RISC-V). (L2) CO2: Illustrate the addressing modes, instruction sets, and stack operations of a microcontroller using assembly language. (L3) CO3: Analyse the functioning and programming of microcontroller peripherals such as Timer, PWM, UART, ADC, and DAC. (L4) CO4: Design interfacing circuits for LEDs, displays, switches, motors, and sensors using Embedded C and simulation tools. (L3) CO5: Examine the embedded system design methodologies and their applicability in Industry 4.0 and biomedical automation. (L4) CO6: Demonstrate a comprehensive embedded application by integrating hardware and software components based on a given case study. (L3)					
Course Content:						

Module 1	Fundamentals of Embedded Systems	Quiz	Memory Recall based Quizzes	15 sessions

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.				
Module 2	Architecture and Programming	Assignment	Programming and Simulation task / Memory Recall based Quizzes	20 sessions
Topics: Introduction to Architecture. Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions. 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	15 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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Industry 4.0	Real-time machine monitoring system	Keil, Proteus, STM32CubeIDE	Manufacturing, Robotics
Biomedical	Heart rate monitoring wearable	ESP32, Arduino IDE	Healthcare, Wearables
Agricultural Automation	Smart irrigation controller	NodeMCU, Blynk App	Agri-tech, Rural Development
Smart Cities	IoT-based street light control	Raspberry Pi, MQTT	Urban Infrastructure

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
ALP with Delay Routines	Practice loops and delays	Keil µVision	Assembly coding, delay generation
UART Communication Test	Implement serial data exchange	Embedded C, Proteus	UART interfacing, debugging
End-Semester Project	Build real-time application	Keil, Proteus, IoT Platform	Prototype development, integration

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):

5. Alexander G. Dean, "Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach", ARM Education Media, 2nd Edition

6. 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.): 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. 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	**Mr. Syed Abrar Ahmed**
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	Understanding of Digital Circuits like Logic Gates, Flip-Flops, Multiplexers, Counters, Registers etc. Basic understanding of microprocessors and microcontrollers (but not mandatory). Simple pseudo instruction of a model microprocessors. Knowledge about real world sensing interfacing. Basic C programming constructs.					
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 <u>EMPLOYABILITY SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> Methodologies.
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Demonstrate assembly and C programming skills for arithmetic, logic, and data transfer operations on a microcontroller. (L3) CO2: Implement interfacing of basic I/O devices namely LEDs, switches, and push buttons using simulation tools. (L3) CO3: Configure and program Timer, PWM, ADC, and DAC modules for waveform generation and signal conversion. (L3) CO4: Integrate temperature sensor, ultrasonic sensor, LCD display and seven-segment display into a functional embedded system. (L4) CO5: Design a small-scale embedded project combining multiple peripherals and real-time constraints. (L3) CO6: Examine the performance and reliability of an embedded system through case study analysis and documentation. (L4)
Course Content:	

List of Laboratory Task:

Exp 01:- Level 1- WAP for Data Transfer operations.
Level 2 - WAP to transfer a block of word from Source to destination memory.

Exp 02:- Level 1 - WAP to find addition/Subtraction of two 32-bit numbers
Level 2- WAP to find sum of ‘n’ 32-bit numbers.

Exp 03:- Level 1- WAP to find multiplication of two 32-bit numbers.
Level 2- WAP to determine the largest and smallest numbers in a given sequence

Exp 04:- Level 1 - WAP to perform Logical operations on two 32 bit numbers.
Level 2 - WAP to sort a sequence of numbers in ascending or descending order

Exp 05:- Level 1- Simulate a program in C for ARM microcontroller to find factorial of a number.
Level 2- Simulate a program in C for ARM microcontroller to demonstrate case conversion of characters from upper to lowercase and lower to uppercase.

Exp 06:- Level 1- Interfacing with basic Input / Output Devices LEDs.
Level 2- Interfacing with basic Input / Output Devices relay switches.

Exp 07:- Interfacing of stepper motors to rotate clockwise and anti-clockwise direction.

Exp 08:- Interfacing of DC motors to rotate clockwise and anti-clockwise direction along with speed control.

Exp 09:- Pulse Width Modulation (PWM) based Waveform Generation and Timing.

Exp 10:- Interfacing of Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Converters.

Exp 11:- Interfacing of UART0 to test its Function.

Exp 12:- Interfacing a 4x4 keypad read a key from key board and displays it on LCD Display.

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.):

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. 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	Mr. Syed Abrar
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: Program Core	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 theory of fault analysis, test generation, and design for testability for digital VLSI circuits and systems. Design and manufacturing defect models are introduced along with test generation and fault simulation algorithms targeting the different fault models. Both combinational and sequential logic testing are covered, and different synthesis for testability schemes such as BIST (Built-In-Self-Test), scan path design, and Core based testing are introduced. The course also demonstrates the test compression and compaction schemes such as code-based schemes, linear decompression-based schemes and test response compaction.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Design for Testability and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					

<table>
<tr><td>Course Outcomes</td><td colspan="5">On successful completion of this course the students shall be able to:

CO1: Explain the importance of VLSI testing, test generation and test technology. (L2)

CO2: Calculate the controllability and observability of VLSI circuits through testability measures. (L3)

CO3: Use scan designs and scan architectures to improve the testability of VLSI circuits. (L3)

CO4: Practice fault models, fault classes, and test pattern generation techniques in VLSI testing. (L3)

CO5: Examine test generation algorithms to identify faults in digital circuits. (L4)

CO6: Employ Built-In Self-Test (BIST) techniques to improve system reliability. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="5"></td></tr>
<tr><td>Module 1</td><td>Introduction to DFT and Fundamentals of DFT</td><td>Assignment/Quizzes</td><td>Memory Recall based Quizzes</td><td></td><td>10 Sessions</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>Module 2</td><td>Scan Insertion and compression</td><td>Assignment</td><td>Simulation and analysis task</td><td></td><td>14 Sessions</td></tr>
<tr><td colspan="6">Topics:

Scan Design Basics, Scan Golden Rules, Scan DRC Checks, Scan Insertion, Generate test protocol and understanding, Lock-Up Latches, Basics for Compression, Compression Techniques, On-Chip-Clocking, hierarchical and boundary scan. Controllability and Observability and related issues.</td></tr>
<tr><td>Module 3</td><td>Introduction to ATPG</td><td>Assignment/Quizzes</td><td>Design Analysis</td><td></td><td>12 Sessions</td></tr>
<tr><td colspan="6">Topics:
Fault models, Fault classes, Pattern generation and simulation, simulations and debugging, Diagnosis flow and fault simulation. Automatic Test Pattern Generation (ATPG) in DFT, ATPG classification, Combinational ATPG (e.g. D, PODEM, FAN), Sequential ATPG.</td></tr>
<tr><td>Module 4</td><td>BIST Architecture, Memory BIST, Logic BIST</td><td>Assignment/Project</td><td>Data Analysis</td><td></td><td>9 Sessions</td></tr>
<tr><td colspan="6">BIST Design Rules, Test Pattern Generation, Exhaustive Testing, Pseudo-Random Testing, Delay Fault Testing, BIST Architectures circuits with scan chain.</td></tr>
<tr><td colspan="6">Targeted Application & Tools that can be used:
Application Area - Hardware design Engineer, DFT engineer, VLSI design Engineer.

Professionally Used Software: Cadence-Modus, Tessent</td></tr>
<tr><td colspan="6">Textbook(s):</td></tr>
</table>

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 relevant to "EMPLOYABILITY SKILLS": Chip Fabrication Process, **Compression Techniques,** BIST Design Rules, Test Pattern Generation -for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms Akshaya M Ganorkar
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

<table>
<tr><td>Course Code: CSS2257</td><td>Course Title: Computer Organization and Architecture
Type of Course: Theory 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="6">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">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="6">To develop a comprehensive understanding of computer system organization by enabling students to analyze processor architecture and instruction execution, explore memory hierarchy and cache mechanisms, examine input/output organization and interfacing and evaluate system performance and optimization techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of this course, students will be able to:
CO1:
Describe the fundamental components of a computer system and their interconnections. [Remember]
CO2:
Explain the concepts of Instruction Set Architecture (ISA) and memory organization. [Understand]
CO3:
Apply techniques to perform arithmetic and logical operations in computer systems. [Apply]
CO4:
Explain the organization and functioning of processor and memory subsystems. [Understand]
CO5:
Analyze the design and performance aspects of computer architecture components for efficient system operation. [Analyze]</td></tr>
<tr><td colspan="7">Course Content:</td></tr>
<tr><td>Module 1</td><td colspan="5">Basic Structure of Computer</td><td>12 Sessions</td></tr>
<tr><td colspan="7">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 colspan="5">Instruction Set Architecture and Memory Unit</td><td>12 Sessions</td></tr>
<tr><td colspan="7">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 colspan="5">Arithmetic And Input/output Design</td><td>10 Sessions</td></tr>
</table>

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

Module 4	**BPU and Pipelining**	**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.

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	On successful completion of this Lab the students shall be able to: CO1: Discuss the basic concepts of MOSFET using MOS device models. (L2) CO2: Illustrate MOS inverters to design efficient MOS circuits. (L3) CO3: Use the large-signal model to analyze and comprehend CMOS sub-circuits. (L3) CO4: Examine the functions of MOS amplifiers using small and large signal models. (L4) CO5: Compare the suitability of common source, common drain, cascode, and folded cascode amplifiers for VLSI integration. (L4) CO6: Interpret circuit-related issues in RF and Mixed IC design. (L3).					
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	11 Sessions
Basics of data converters; Analog Testing, Floor Planning and Layout issues; Mixed signal design and layout issues; Low Voltage and Low Power Circuits; Introduction to RF Electronics, Introduction to current mode VLSI design.				

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Analog Circuit Design	Design of CMOS-based Rectifier Circuits	Cadence Virtuoso	Consumer Electronics
OpAmp Design	2-stage OpAmp design and simulation	Cadence Virtuoso	Automotive & Biomedical
Differential Amplifier Tuning	Optimize W/L for Gain, Slew Rate, Bandwidth	Cadence Virtuoso	Communication Systems
Low Power VLSI	Layout for low voltage, low leakage circuits	Cadence Virtuoso	Wearables and IoT

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Differential amplifier design	Achieve required gain, slew rate and bandwidth	Cadence Virtuoso (schematic & layout)	Analog amplifier sizing; AC & transient analysis
Two-stage op-amp implementation	Design a high-performance op-amp circuit	Cadence Virtuoso with parametric sweeps	Op-amp architecture; performance optimisation
CMOS rectifier design	Simulate diode behaviour for energy conversion	Cadence Virtuoso	Power-conversion circuits; MOS-diode modelling
Low-power layout	Minimise power leakage in layout	Cadence Virtuoso layout editor	Low-power layout techniques; leakage reduction

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

E-content:

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

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

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

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

<table>
<tr><td>Course Code:
ECE2572</td><td>Course Title: CMOS VLSI Design Lab
Type of Course: Program Core Lab</td><td>L- T-P- C</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Version No.</td><td colspan="6">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">Analog electronics, Linear Integrated Circuits, Network Theory.</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">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.</td></tr>
<tr><td>Course Objective</td><td colspan="6">The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of this Lab the students shall be able to:
CO1: Characterize MOS transistors and CMOS inverter through experimental analysis. (L4)
CO2: Implement CMOS-based universal gates using EDA tools. (L3)
CO3: Develop layouts of basic CMOS circuits using EDA tools. (L6)
CO4: Examine the functionality of common source and common drain amplifiers based on simulation results. (L4)
CO5: Determine the characteristics of differential and operational amplifiers. (L4)
CO6: Analye the performance of DAC circuits under different operating conditions using EDA tools. (L4)</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td colspan="7">List of Laboratory Tasks:
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 VDS` (Drain to Source voltage) for different values of Vgs (Gate to Source voltages). Find ID, Vgs and VDS. In which region is the transistor operating?

2. Design and simulate CMOS schematic Invertor Circuit and verify the following: DC Analysis, AC Analysis and Transient Analysis.
3. Design and simulate CMOS based schematic two input universal gates and verify the following: DC Analysis, AC Analysis and Transient Analysis.
4. Implement CMOS Invertor: Draw the Layout and verify the DRC, ERC, Check for LVS, Extract RC and back annotate the same and verify the design.

5. Implement CMOS Two Input Universal Gates: 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 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-(b is an optional).</td></tr>
</table>

7. 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**-(b is an optional).**

8. 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 - **(b is an optional).**

9. Design an op-amp with given specification using given differential amplifier & Common source amplifier in the 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- **(b is an optional).**

10. 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**- (b is an optional).**

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools & Techniques Used	Relevant Industries
Analog & Mixed Signal IC	Design of Amplifiers	Cadence Virtuoso	Semiconductors
Custom Layout	Layout of Logic Gates	Virtuoso Layout Editor	EDA Tools
Digital IP Integration	OpAmp & DAC IP Usage	Cadence ADE	ASIC Design
Verification	LVS, DRC, Parasitic Extraction	Assura/Calibre	Foundries

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Differential amplifier design	Tune gain, bandwidth & slew rate	Cadence Virtuoso	Analog amplifier sizing
Two-stage op-amp design	Achieve high gain through IP reuse	Custom IP reuse	Op-amp architecture
CMOS rectifier	Develop voltage-control circuit	Cadence schematic/layout	Power-rectifier design

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. 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 Manikandan T**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: CSS2264	Course Title: Essentials of AI Type of Course: -Theory Course (PCC)	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.					
Course Objectives	To develop a foundational understanding of Artificial Intelligence by enabling students to explore search strategies and problem-solving techniques, study knowledge representation and reasoning and analyze real-world AI applications.					
Course Outcomes	On successful completion of this course, students will be able to: **CO1:** Explain various search techniques, problem-solving methods, and inference mechanisms in Artificial Intelligence. [Understand] **CO2:** Explain graphical and adversarial search algorithms used in AI. [Understand] **CO3:** Apply first-order logic and resolution techniques to solve reasoning problems. [Apply] **CO4:** Apply Hidden Markov Models (HMM) to solve sequence labeling problems. [Apply] **CO5:** Apply deep learning techniques to analyze and solve AI-based problems. [Apply]					
Course Content:						
Module 1	**Search Methods for Problem-Solving**			**12 Sessions**		
Topics: Introduction – 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**			**12 Sessions**		
Topics: **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 Representation**			**12 Sessions**		
Topics: **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**	**09 Sessions**

Topics:
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.

Course Code: CSS2265	Course Title: Essentials of AI Lab Type of Course: Laboratory Course (PCC)	L-T-P-C	0-0-2-1
Version No.	1.0		
Course Pre-requisites	NIL		
Anti-requisites	NIL		
Course Description	This course introduces students to the fundamentals and practical applications of Artificial Intelligence through hands-on laboratory exercises. Students will explore AI tools, prompt engineering, generative AI, Natural Language Processing (NLP), basics of Machine Learning, chatbot development, recommendation systems, ethical AI, and voice assistant simulation. The course concludes with the development of AI-based mini projects for real-world applications.		
Course Objectives	To develop practical skills in Artificial Intelligence by enabling students to explore AI tools, apply prompt engineering techniques, implement basic NLP and Machine Learning tasks, develop intelligent AI-based applications, and analyze ethical and real-world aspects of AI systems.		
Course Outcomes	On successful completion of this course, students will be able to: **CO1:** Apply AI tools and prompt engineering techniques for generating effective AI-based outputs.. [Level 3 – Apply] **CO2:** Implement AI-based applications for text generation, image generation, and chatbot development. . [Level 3 – Apply] **CO3:** Apply Natural Language Processing and basic Machine Learning techniques for solving simple real-world problems.. [Level 3 – Apply] **CO4:** Analyze datasets and AI model outputs using preprocessing, visualization, and evaluation techniques. [Level 4 – Analyze] **CO5:** Analyze ethical issues, bias, and the impact of AI systems in practical applications [Level 4 – Analyze]		

Course Content:

Lab Sheet 1: Introduction to AI Tools

- **Problem Statement:**
- Explore different AI platforms such as ChatGPT, Gemini, and Hugging Face, and compare their outputs for various tasks based on relevance and accuracy.

Lab Sheet 2: Prompt Engineering Basics

- *(Using AI tools explored in Lab 1)*
- **Problem Statement:**
- Design effective prompts for text generation and summarization, and analyze how prompt structure influences AI-generated responses.

Lab Sheet 3: Advanced Prompt Engineering

- *(Continuing Lab 2)*
- **Problem Statement:**
- Develop role-based and instruction-based prompts to optimize AI outputs for accuracy, detail, and contextual understanding.

Lab Sheet 4: AI Content Generation

- *(Using prompts designed in previous labs)*
- **Problem Statement:**
- Generate blogs, emails, resumes, and reports using AI tools and improve the outputs through iterative prompt refinement.

Lab Sheet 5: AI Image Generation

- *(Extending prompt engineering concepts)*
- **Problem Statement:**
- Generate AI-based posters, logos, and advertisements using generative AI tools and compare outputs generated using different prompt styles.

Lab Sheet 6: Dataset Collection & Preprocessing

- **Problem Statement:**
- Collect textual datasets from reviews or social media platforms and perform preprocessing techniques such as tokenization, stemming, and stopword removal.

Lab Sheet 7: Sentiment Analysis using NLP

- *(Using dataset prepared in Lab 6)*
- **Problem Statement:**
- Implement sentiment analysis on textual datasets using NLP libraries and analyze sentiment classification performance.

Lab Sheet 8: Text Summarization & Translation

- *(Continuing NLP tasks from Lab 6 & 7)*
- **Problem Statement:**
- Implement AI-based text summarization and language translation techniques and compare generated outputs with original content.

Lab Sheet 9: Introduction to Machine Learning

- *(Using processed datasets from previous labs)*
- **Problem Statement:**
- Understand supervised and unsupervised learning concepts by loading, splitting, training, and testing datasets using Scikit-learn.

Lab Sheet 10: Data Visualization & Feature Analysis

- *(Continuing Lab 9 using same dataset)*
- **Problem Statement:**
- Visualize datasets using Matplotlib and analyze feature relationships and data distributions using graphical techniques.

Lab Sheet 11: AI Chatbot Development

- *(Using NLP and prompt engineering concepts)*
- **Problem Statement:**
- Develop a rule-based chatbot using Python and integrate contextual AI-generated responses for interactive communication.

Lab Sheet 12: Recommendation System

- *(Using prediction concepts from previous labs)*
- **Problem Statement:**

- Implement a content-based recommendation system and analyze recommendation accuracy using similarity metrics.

Lab Sheet 13: Ethical AI and Bias Analysis

- *(Evaluating outputs generated in previous labs)*
- **Problem Statement:**
- Identify bias, hallucination, and ethical issues in AI-generated outputs and analyze their impact on responsible AI systems.

Lab Sheet 14: Voice Assistant Simulation

- *(Using NLP and chatbot concepts from previous labs)*
- **Problem Statement:**
- Develop a basic voice assistant using Python speech libraries and implement voice commands for search, greetings, and simple automation tasks.

Lab Sheet 15: AI Mini Project

- *(Combining concepts from all previous labs)*
- **Problem Statement:**
- Develop and demonstrate an AI-based application integrating concepts such as NLP, machine learning, chatbot systems, or recommendation systems.

Targeted Application & Tools that can be used:

1. ChatGPT, Gemini, Hugging Face, Canva AI, Python
2. Python IDEs like PyCharm-Jupyer Notebook /Google Collab

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.
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022

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.

<table>
<tr><td>Course Code: ECE2515</td><td colspan="2">Course Title: Mixed Signal Circuit 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="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">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.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">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.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:
CO1: Summarize the basics of Metal Oxide Semiconductor Field Effect Transistor (MOSFET) characteristics and Operational Amplifier circuits.
CO2:Apply the principles of two-stage and folded cascode operational amplifiers to design comparator circuits
CO3:Design filters, amplifiers, and converters based on switched capacitor circuit principles
CO4:Demonstrate the Phase Locked Loop concept suitable for circuit applications
CO5: Examine the performance characteristics of A/D and D/A converters.
CO6: Synthesize second-order filter topologies using integrators to meet frequency response requirements.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Operational amplifiers and Comparators</td><td>Assignment / Quiz</td><td colspan="3">Memory recall based Quiz</td><td colspan="2">12 Sessions</td></tr>
<tr><td colspan="8">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. Stability and frequency compensation of op-amps. Phase margin and noise in op-amps.</td></tr>
<tr><td>Module 2</td><td>Switched capacitor circuits and PLL</td><td>Assignment / Quiz</td><td colspan="3">Implementation using Simulation Tools</td><td colspan="2">13 Sessions</td></tr>
<tr><td colspan="8">Topics:
Switched capacitor circuits: Basic building blocks, basic operation and analysis, inverting and non-inverting integrators, Sample and hold circuits - Performance requirements, MOS sample and hold basics, clock feed through problems,
Phase locked loops: Basic loop architecture. PLLS with charge pump phase comparators – dynamics of PLLS. Voltage controlled oscillators, characteristics of PLLS. Applications of PLLS.</td></tr>
<tr><td>Module 3</td><td>Fundamentals and Classification of Convertors</td><td>Assignment / Application</td><td colspan="3">Implementation using Simulation Tools</td><td colspan="2">10 Sessions</td></tr>
</table>

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.

Module 4	**Analog Filters**	Assignment / Quiz	Programming task	10 Sessions

Analog Filter: Integrator Building Blocks- Lowpass Filters, Active-RC Integrators, MOSFET-C Integrators, Discrete-Time Integrators, Filtering Topologies- The Bi-linear Transfer Function, Bi-quadratic Transfer Function

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	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: ECE2523	Course Title: Digital VLSI Design Type of Course: Program Core, Theory only	L- T-P- C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Low Power VLSI Design, Foundations for VLSI Design					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the fundamentals of Digital and embedded systems. The course insights into the various methodology and models for real-world circuits and enhances student's abilities to implement programmable logic devices for specific chip design. The course emphasizes on memory types with error detection and correction techniques and also demonstrates the use of Hardware Description Language (HDL) to develop designs for high level synthesis and simulation.					
Course Objective	This course is designed to improve the learners' <u>EMPLOYABILITY SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques using open source Design Tools.					
Course Outcomes	On successful completion of the course students shall be able to: CO1: Explain the basics of HDLs, VLSI design flow, and Verilog language elements (modules, ports, data types, operators, system tasks) for understanding how Verilog is used in digital design. (L2)					

<table>
<tr><td></td><td colspan="4">CO2: Apply gate-level and dataflow modelling in Verilog for designing and simulating simple combinational circuits like adders, Subtractor, multiplexers, decoders, and comparators. (L3)

CO3: Develop behavioral models in Verilog using always/initial blocks, loops, tasks, and functions for describing flip-flops, shift registers (L6)

CO4: Use behavioral models to build FSMs for simulating complex sequential circuits(L3)

CO5: Design arithmetic circuits and simple memories in Verilog for building efficient hardware units. (L6)

CO6: Implement digital systems using programmable logic devices (ROM, PLA, PAL) for creating flexible hardware designs (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Verilog</td><td>Quiz</td><td>Memory Recall based Quiz</td><td>10 Session</td></tr>
<tr><td colspan="5">Topics:
Introduction to HDLs, VLSI Design flow, importance and trends in Verilog. Verilog language elements: Modules, ports, data types, operators, lexical conventions, system tasks, Compiler Directives, Difference between System tasks and Functions.</td></tr>
<tr><td>Module 2</td><td>Data flow and gate level modelling</td><td>Assignment</td><td>Design and Simulation Based</td><td>09 Session</td></tr>
<tr><td colspan="5">Topics:
Gate Level modelling, gate primitives, delays, Data flow Modelling, continuous assignment statement, delay specification, Combinational and simple sequential circuits. Adders, Subtractor, Mux, Demux, Encoder and Decoder , Comparator circuits</td></tr>
<tr><td>Module 3</td><td>Behavioral modelling</td><td>Project</td><td>Simulation and small hardware based</td><td>13 Session</td></tr>
<tr><td colspan="5">Topics:
Behavioral modelling (always, initial, blocking/non-blocking), Conditional statement, Multiway branching, loops, sequential and parallel blocks. Difference between task and functions, Sequential circuits. Flip Flops, Shift Registers, Counters, FSMs (Mealy and Moore)</td></tr>
<tr><td>Module 4</td><td>Designing with programmable Logic Devices</td><td>Project</td><td>Software design based</td><td>13 Session</td></tr>
<tr><td colspan="5">Topics:
Read only memories, Programmable Logic Arrays, Programmable Array Logic, Other sequential programmable Logic Devices (PLDs), Generics, Generate statements. Design of Networks for Arithmetic Operations: Design of serial Adder with Accumulator, Design of Binary Multiplier, Implementation on memories (RAM and ROM)</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">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</td></tr>
</table>

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 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition. T2 Fundamentals of Logic Design", Charles H Roth Jr. & Barry L Kinney, Cengage learning, 2010
Reference(s): Reference Book(s): **1.** Ming-Bo Lin, ''Digital System Designs and Practices: Using Verilog HDL and FPGAs", Wiley, 2008 **2.** Donald E. Thomas, Philip R Moorby, 'TheVerilog Hardware Description Language", Springer, Fifth edition. **3.** Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition. **4.** 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. Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language | IEEE Conference Publication | IEEE Xplore 3. 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. Kehkeshan Jalall S
Recommended by the Board of Studies on	10^{th} BOS held on 17/01/2020
Date of Approval by the Academic Council	Meeting No. 16^{th} , 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 using Verilog .					
Course Objective	The objective of the course is to SKILL DEVELOPMENT of students by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	**CO1:** Develop basic Verilog modules and test benches for simulating simple combinational gates and circuits in Xilinx Vivado. **CO2:** Implement combinational circuits (multiplexer, demultiplexer, adder, Subtractor, comparator, encoder, decoder) using gate-level and dataflow modelling for verifying their functionality through simulation. **CO3:** Design sequential circuits (flip-flops, shift registers, counters) using behavioral modelling for observing clocked behavior and reset functionality in waveforms. **CO4:** Model finite state machines (Mealy and Moore) in Verilog for detecting sequences and controlling state transitions with proper test bench verification. **CO5:** Create arithmetic circuits (serial adder with accumulator, binary multiplier) using behavioral Verilog for simulating correct numerical operations. **CO6:** Design simple memory (RAM or ROM)using verilog for data storage applications					
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) **Experiment 1:** Introduction to Verilog & Vivado						

Level1: Write and simulate a simple Verilog module for 2-input AND, OR, and NOT gates using all three modelling styles. Create testbench observe waveforms in Vivado.

Level2: Write and simulate a simple Verilog module for half adder and half Subtractor gates using all three modelling styles. Create testbench and observe waveforms in Vivado.

Experiment 2: Dataflow Modelling

Level1: Design and simulate a 4:1 Multiplexer and 1:4 Demultiplexer using continuous assignment (dataflow style) with delay specification. Verify all select lines.

Level2: Design and simulate a 8:1 Multiplexer and 1:8 Demultiplexer using continuous assignment (dataflow style) with delay specification. Verify all select lines.

Experiment 3: Gate-Level Modeling

Level1: Implement a 4-bit Ripple Carry Adder using gate primitives with propagation delay. Simulate and check carry/borrow output.

Level2: Implement a 4-bit Subtractor using gate primitives with propagation delay. Simulate and check carry/borrow output.

Experiment 4: Combinational Circuit Design

Level1: Design a BCD to 7-Segment Decoder using dataflow/gate-level modeling. Simulate all input combinations.

Level2: Design a 2-bit BCD to 7-Segment Decoder using dataflow/gate-level modeling. Simulate all input combinations.

Experiment 5: Encoder & Decoder

Level1: Implement a 8-to-3 Priority Encoder using dataflow style. Add testbench to verify priority logic.

Level2: Implement a 3-to-8 Decoder using dataflow style. Add testbench to verify priority logic.

Experiment 6: Behavioral Modeling – Sequential Circuits

Level1: Design and simulate D Flip-Flop, JK Flip-Flop and T Flip-Flop using always block with blocking. Include reset.

Level2: Design and simulate D Flip-Flop, JK Flip-Flop and T Flip-Flop using always block with non-blocking assignments. Include reset.

Experiment 7: Shift Registers & Counters

Level1: Write behavioral Verilog code for 4-bit SIPO Shift Register. Simulate and observe the output.

Level2: Write behavioral Verilog code for 4-bit Up/Down Counter. Simulate and observe the output.

Experiment 8: Finite State Machine (FSM)

Level1 Design a Mealy FSM for sequence detector (detect “1011”) using behavioral modeling. Write complete testbench and verify states.

Level 2 Design a Moore FSM for sequence detector (detect “1011”) using behavioral modeling. Write complete testbench and verify states.

Experiment 9: Arithmetic Circuits

Level1: Design a Serial Adder with Accumulator, Write the test bench and simulate with different values

Level2: Design 4-bit Array Multiplier using behavioral style. Write the test bench imulate with different input values.

Experiment 10: Memory & Programmable Logic

Level1: Implement a 16×8 Synchronous RAM using Verilog (with generics). Simulate read/write operations and synthesize on FPGA`

Level2: Implement a 16×8 Synchronous 8×8 ROM using Verilog (with generics). Simulate read/write operations and synthesize on FPGA`

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Memory Design	SRAM/DRAM simulation & layout	Verilog HDL	Embedded Automation
Arithmetic Circuits	Adders, subtractors, MUX/DEMUX	Xilinx Vivado	Digital Electronics, Embedded Systems
Traffic Control	Flip-flop based control FSM		

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Gate verification using bulb–switch logic	Understand gate operations at system level	Verilog, simulation tools	Logic verification; circuit debugging
4-bit ripple-carry adder	Develop hierarchical Verilog modelling	Vivado + FPGA board	Combinational logic design; hierarchical modelling
Traffic-light FSM	FSM design for real-time applications	Verilog, case statements, FPGA	Finite-state machine design; real-time control

Project work/Assignment:

1. Write a Verilog code to design a Mealy Finite State machine without overlap to detect given and sequence & verify its output
2. Design a 8*8 RAM memory using Verilog

Text Books:

T1 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
T2 Fundamentals of Logic Design”, Charles H Roth Jr. & Barry L Kinney, Cengage learning, 2010

Reference(s):
Reference Books

1. Ming-Bo Lin, ''Digital System Designs and Practices: Using Verilog HDL and FPGAs", Wiley, 2008
2. E. Thomas, Philip R Moorby, 'The Verilog Hardware Description Language", Springer, Fifth edition.
3. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition.

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

1. Introduction to Hardware Modelling 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:

1. Verilog HDL based FPGA design | IEEE Conference Publication | IEEE Xplore
2. Implementation of Smart Home through FPGA using Verilog Hardware Descriptive Language | IEEE Conference Publication | IEEE Xplore
3. https://presiuniv.knimbus.com/openFullText.html?DP=http://182.72.188.196/LocalGuru/

Topics related to the development of "FOUNDATION SKILLS":
Topics related to the development of "EMPLOYABILITY":.

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	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 Linear Integrated Circuits and attain the SKILL DEVELOPMENT through EXPERIENTIAL LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Apply VLSI design and verification flow concepts to digital system development. CO2: Apply functional verification using System Verilog testbenches. CO3: Analyze formal, timing, and coverage-driven verification techniques.					

	CO4: Develop reusable UVM-based verification environments. CO5: Implement automated verification flows using scripting and industry tools for simulation, debugging, and coverage closure. CO6: Evaluate advanced verification techniques for ASIC/FPGA designs.				
Course Content:					
Module 1	Introduction to VLSI Design and Verification	CA1	Memory Recall based Quizzes		11 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	CA2	Simulation and analysis task		12 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	Quiz or Assignment	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	Quiz or Assignment	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, Verification engineer, Synthesis engineer.
Professionally Used Software: Cadence-Modus, Tessent, Modelsim

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

Reference Books:

R1. Z.Navabi, "*Digital System Test and Testable Design*", Springer, 2011.

R2. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, System-on-Chip Test Architectures: Nanometer Design for Testability, Morgan Kaufmann, First Edition, 2010.

R3. Huertas JL, (editor), "Test and design-for-testability in mixed-signal integrated circuits", The Netherlands: Kluwer Academic; 2004.

Online Resources

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

Topics relevant to "SKILL DEVELOPMENT": Amplifiers, comparators, multivibrators and converters for Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Aruna M
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, Basic HDL, System Verilog, UVM, TCL, Linear Integrated Circuits, Network Theory, Digital design.					
Anti-requisites	NIL					
Course Description	This course provides a comprehensive understanding of digital VLSI design, simulation, and verification with hands-on laboratory experiments. It covers RTL design and simulation of combinational and sequential circuits using Verilog and System Verilog. Students learn to develop testbenches, apply assertions, and perform coverage-driven verification for ensuring design correctness. The course					

	introduces advanced verification methodologies such as UVM for building scalable and reusable verification environments. It also focuses on FPGA-based design implementation using Xilinx Vivado, including synthesis, implementation, and resource utilization analysis. Students will explore timing analysis and static timing verification to identify and resolve setup and hold violations. The course emphasizes low-power design techniques such as clock gating and power-aware simulation. Additionally, scripting using Python and TCL is introduced for automating verification workflows and improving efficiency. FPGA hardware validation is also covered to bridge the gap between simulation and real-time implementation. Overall, the course equips students with practical skills and industry-relevant knowledge to design, verify, and optimize modern VLSI systems.
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 VLSI design flow for modeling and simulation using Verilog/ System Verilog. CO2: Develop testbenches and verify designs using assertions. CO3: Use UVM for advanced verification. CO4: Analyze coverage metrics for design validation. CO5: Implement designs on FPGA using Xilinx Vivado. CO6: Perform timing analysis and apply low-power optimization techniques.
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/ System Verilog.
Level 2: Verifying the functionality of the design and debugging simulation results using a waveform viewer.

Experiment No. 2: Introduction to VLSI Design Flow and Simulation
Level 1: Performing RTL simulation of a simple Sequential circuit (e.g., Mealy/Moore state machine) using Verilog/ System Verilog.
Level 2: Verifying the functionality of the design and debugging simulation results using a waveform viewer.

Experiment No. 3: Writing Testbenches in System Verilog
Level 1: Writing a basic testbench for a combinational design (e.g., AND gate, OR gate) in System Verilog.
Level 2: Implementing assertions in the testbench to check for functional correctness and generating a coverage report.

Experiment No. 4: 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. 5: 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. 6: FPGA Synthesis, Implementation, and Resource Utilization Analysis

Level 1: Synthesize and implement the design on FPGA using Xilinx Vivado Design Suite and generate the utilization report.

Level 2: Analyze LUT and flip-flop usage along with power and timing trade-offs. Identify resource bottlenecks and inefficient logic in the design. Optimize the design using techniques like pipelining, resource sharing, and logic simplification.

Experiment No. 7: 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. 8: 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. 9: 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. 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: Vivado/Modelsim/Cadence Virtuoso

Project work/Assignment:

1. Design and implement a power-aware VLSI circuit using static and dynamic clock gating techniques, analyze switching activity, and compare power reduction with a non-gated design.

2. Develop an optimized pipelined architecture for a digital system (e.g., ALU or multiplier), evaluate performance improvement, and analyze trade-offs between area, power, and timing.

3. Create a complete UVM-based verification environment for a complex digital design (e.g., FIFO or UART), implement constrained random testing, and achieve maximum functional coverage.

4. Perform detailed static timing analysis (STA) on a synthesized design, identify critical paths and timing violations, and optimize the design using retiming and logic restructuring techniques.

5. Design and implement a low-power FPGA-based system using Xilinx Vivado, apply techniques such as clock gating and resource sharing, and evaluate power, timing, and area trade-offs.

Text Books:

3. M. Morris Mano, *Digital Design*, 5th Edition, Pearson Education, 2013.
4. Samir Palnitkar, *Verilog HDL: A Guide to Digital Design and Synthesis*, 2nd Edition, Prentice Hall, 2003.
5. Chris Spear and Greg Tumbush, *SystemVerilog for Verification: A Guide to Learning the Testbench Language Features*, 2nd Edition, Springer, 2008.
6. Janick Bergeron, *Writing Testbenches using SystemVerilog*, Springer, 2006.
7. Ray Salemi, *The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology*, 2013.

8. Pong P. Chu, *FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version*, Wiley-Interscience, 2008.
9. J. Bhasker and Rakesh Chadha, *Static Timing Analysis for Nanometer Designs: A Practical Approach*, Springer, 2009.

Reference(s):

Reference Books

5. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, *Digital Integrated Circuits: A Design Perspective*, 2nd Edition, Prentice Hall, 2003.
6. Neil H. E. Weste and David Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson, 2011.
7. Xilinx Inc., *Vivado Design Suite User Guide*, 2020.

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. Aruna M, Archana Nair, Vishnavi, Shilpa Suresh Jagadal, Yashaswini Yadav B S. "Power - Aware VLSI Synthesis Using Static and Dynamic Clock Gating Techniques", *In iementech 2026,* 2026 pp. 26-32. IEEE, 2026. https://ieeexplore.ieee.org/document/11434393

8. 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
9. 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
10. 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
11. Kumar, Vikash, Rishab Mehra, and Aminul Islam. "A 2.5 GHz Low Power, High-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	Mrs. Aruna M
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: CO1:Explain the fundamentals of VLSI design automation tools essential for efficiently handling large-scale integrated circuits. (L2) CO2:Describe the algorithms used in VLSI design for compaction, partitioning, and placement (L3) CO3:Employ algorithms for Floor planning in VLSI design (L3) CO4:Illustrate the working of routing algorithms used in VLSI design (L3) CO5:Demonstrate the construction of Reduced Ordered Binary Decision Diagrams (ROBDD) for efficient Boolean function representation in VLSI design.(L3) CO6:Analyze an end-to-end ASIC /Soc Physical design flow using scheduling algorithm and high level synthesis in VLSI(L4)							
Course Content:								
Module 1	Design automation tools	Quiz	Memory Recall based Quizzes	6 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	12 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	18 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. Introduction to Testing, Fault Modeling and Simulation. Test Pattern Generation, DFT and BIST. Low Power Design Techniques

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	ASHMITA MOIDU, Assistant 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	L-T- P- C	0	0	2	1
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: CO1:Explain the stages of the VLSI design flow using Cadence EDA tools s namely Incisive, Genus, and Innovus at each stage. CO2:Apply Cadence software tools to implement and study physical design parameters of basic digital circuits such as adders and multipliers. CO3:Apply Cadence software tools for combinational and sequential circuits to obtain their floor plan.					

	CO4:Analyze Finite State Machines, clock divider circuits, and clock domain crossing (CDC) principles using EDA tools CO5:Apply EDA tools to evaluate FIFO memory architectures in physical design. CO6:Analyze optimization-based physical design approaches using Simulated Annealing algorithms.
Course Content:	

List of Laboratory Tasks:

EXPERIMENT 1

Introduction to Cadence EDA Tools (Incisive, Genus, Innovus)

EXPERIMENT 2

Physical design analysis of Digital Adders (Ripple & CLA)

EXPERIMENT 3

Physical design analysis of Digital Multiplier

EXPERIMENT 4

ALP for addition, subtraction / Multiplication using successive addition

EXPERIMENT 5

Physical design analysis of 4-bit ALU

EXPERIMENT 6

Physical design analysis of Synchronous & Asynchronous Counters

EXPERIMENT 7

Physical design analysis of FSM (Mealy/Moore sequence detector)

EXPERIMENT 8

Physical design analysis of Clock Divider Circuit

EXPERIMENT 9

Physical design analysis of Clock Domain Crossing (CDC)

EXPERIMENT 10

Physical design analysis of FIFO Memory

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	ASHMITA MOIDU
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: 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: 1. Explain the physical principles and challenges in RF and HF circuit design. 2. Analyze the performance of RF components including amplifiers, mixers, and oscillators. 3. Design and simulate RF building blocks using CMOS technology. 4. Interpret S-parameters, noise figures, and matching network requirements for RF ICs. 5. Evaluate RF circuit layout considerations and parasitic effects in integrated design.						
Course Content:							
Module 1	Introduction to RF and HF Circuit Design	Assignment/ Quiz	Numerical solving Task	10 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							

<table>
<tr><td>Module 3</td><td>Mixers and Oscillators</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td>12 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Frequency Synthesizers and Layout Considerations</td><td>Assignment/ Quiz</td><td>Numerical solving Task</td><td>12 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">Project Work/ Assignment:</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">Text Book(s):
1. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed., Cambridge University Press, 2004.
2. Behzad Razavi, RF Microelectronics, 2nd ed., Pearson Education, 2011.</td></tr>
<tr><td colspan="5">Reference Book (s):
1. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design, 2nd ed., Pearson, 2009.
2. 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</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Catalogue prepared by</td><td colspan="4"></td></tr>
<tr><td>Recommended by the Board of Studies on</td><td colspan="4"></td></tr>
<tr><td>Date of Approval by the Academic Council</td><td colspan="4"></td></tr>
</table>

Date of Approval by the Academic Council	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: CO1: Calculate the static characteristics of instrumentation systems using measured data.(L3) CO2: Determine measurement errors using statistical analysis techniques for instrument calibration.(L3) CO3: Explain bridge circuit principles for measuring resistance, capacitance, and inductance.(L2) CO4: Describe the operation of digital measuring instruments and waveform generators for electrical measurements.(L2) CO5: Illustrate the operating principles of displacement, pressure, temperature and proximity sensors for physical parameter measurement. (L2) CO6: Determine the physical parameters using displacement, pressure, temperature, and proximity sensors.(L3)					
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):

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

References

1. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press / PHI. 2^{nd} Edition, 2006.
2. H. S. Kalsi, "Electronic Instrumentation", McGraw Hill., 4^{th} Edition, 2018.
3. Online videos of lab-VIEW compatible NI devices., 2^{nd} 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 Council	Meeting No. 16th , Dated 23/10/2021

Course Code: ECE3201	**Course Title: Bio-Medical Instrumentation** **Type of Course: : Discipline Elective-Signal Processing Basket**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	[1] Linear Integrated Circuits, 2] Measuring Instruments and Sensors					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to appreciate the need for Biomedical Instrumentation and Role of engineers in biomedical field. The course is conceptual in nature which allows the students to understand the application of various engineering concepts used in biomedical for diagnosis, treatment and prevention of diseases.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Bio-Medical Instrumentation and to improve the <u>Employability Skills</u> of student by using <u>Participative Learning</u> techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Explain the fundamental blocks of biomedical instrumentation systems, including transducers, signal conditioning units, processing units, display devices, and recording systems. (L2) CO2: Describe the operating principles, characteristics, and applications of biomedical transducers for physiological parameter measurement. (L2) CO3: Demonstrate the working principles of patient monitoring systems used for cardiovascular parameter measurement, including blood pressure, blood flow, pulse rate, and oxygen saturation.(L3) CO4: Discuss the working principles of patient monitoring systems used for respiratory parameter measurement, including lung volume and lung capacity measurement. (L2) CO5: Discuss the working of ECG, EEG, EMG, and EOG recording systems through bioelectric signal propagation and electrode configurations. (L2) CO6: Differentiate the principles and system components of medical imaging modalities including X-ray, CT, ultrasound, and MRI for medical diagnosis. (L4)					
Course Content:						

Module 1	Introduction to Biomedical	Assignment	A short note on instruments used in medical field for diagnosis, treatment and prevention of diseases	**08 Sessions**

<table>
<tr><td></td><td>Instrumentation system</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Topics:
Role of Technology in Medicine, Physiological Systems of the Body, Basic Medical Instrumentation System, Wireless Connectivity in Medical Instruments, Classification of Transducers, Optical Fibre Sensors, Biosensors, Smart Sensors, A basic recording system, Types of preamplifiers. Basic components of BMI systems, Classification of Transducers, Potentiometric transducer, variable capacitance, variable inductance, Piezo-electric Transducer, Strain gauge pressure transducer, Thermocouple, Thermistor, A basic recording system, General consideration for signal conditioners, Types of preamplifiers, differential, instrumentation amplifiers, isolation amplifier, chopper amplifiers. Biotelemetry</td></tr>
<tr><td>Module 2</td><td>Patient Monitoring System</td><td>Case Study</td><td>Any one state of art patient monitoring systems</td><td>09 Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to patient monitoring system, Types of patient monitoring system, Blood pressure measurement: Direct and Indirect method of blood pressure measurement, Phonocardiograph (PCG) for heart sound measurement, Blood Flow meter: Electromagnetic blood flow meters, Ultrasound, Dye dilution, thermal dilution method etc. Spirometer for lung volume and lung capacity measurement. Pulse rate measurement using IR principle.</td></tr>
<tr><td>Module 3</td><td>Bioelectric Recorders</td><td>Assignment</td><td>Different types of electrodes, its features and specific application</td><td>10 Sessions</td></tr>
<tr><td colspan="5">Topics:
Origin of bioelectric signals, polarization, depolarization, hyperpolarization. Propagation of bioelectric potentials. Electrode tissue interface, surface and deep-seated Electrodes. ECG: Function of heart, conduction path way, placement of electrodes, lead configurations. Block Diagram of an Electrocardiograph. EEG: Introduction to EEG, 10-20 system of placement of electrodes, Block Diagram of Electroencephalograph, EMG: Introduction to EMG, Block Diagram of EMG recording, Introduction to EOG.</td></tr>
<tr><td>Module 4</td><td>Modern Imaging System</td><td>Case study</td><td>Trends and recent research projects based on medical images</td><td>8 Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to medical imaging, Methods of Monitoring Foetal Heart Rate, Monitoring Labour Activity, Oximeters, Blood Flow Measurement, Methods of blood Cell Counting, Safety Codes for Electromedical Equipment,
Introduction to medical imaging, Basics of diagnostics radiology, X-ray: Production of X-ray, X-ray Machine, application X-ray, CT: Basic Principle, CT Scan system components, Ultrasound: Principle of Ultrasound, Application of ultrasound in biomedical. MRI: Basic Principle, MRI Scan system components.</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:

Multisim for simulating the signal conditioners used in BMI. MATLAB, LabVIEW for preprocessing the raw data and extraction of features using signal and image processing. Any microcontrollers and FPGA for developing embedded systems for Biomedical Field for processing, displaying recording and transmitting the real time data.</td></tr>
<tr><td colspan="5">Textbook(s):
1. R S Khandpur, “Handbook of Biomedical Instrumentation”, McGraw Hill Education, 3rd edition, 2014.
2. J. Webster, “Medical Instrumentation: Applications and Design”, John Wiley and Sons, 4th edition, 2009.</td></tr>
<tr><td colspan="5">References
1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, “Biomedical Instrumentation and Measurements”, Prentice Hall India Learning Private Limited, 1st edition, 1990.</td></tr>
</table>

2. Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation", Prentice Hall India Learning Private Limited, 1st edition, 2013.
Digital References **1. NPTEL - https://nptel.ac.in/courses/108/105/108105101/** **2. Coursera - https://www.coursera.org/learn/bioengineering** **3. Udemy - https://www.udemy.com/course/biomedical-engineering-instrumentation-course-rahbme216-rahsoft/**
E-Contents 1. Karthick, R., R. Ramkumar, Muhammad Akram, and M. Vinoth Kumar. "Overcome the challenges in bio-medical instruments using IOT–A review." *Materials Today: Proceedings* 45 (2021): 1614-1619. 2. Fedtschenko, Tatjana, Alexander Utz, Alexander Stanitzki, Andreas Hennig, Andre Lüdecke, Norbert Haas, and Rainer Kokozinski. "A new configurable wireless sensor system for biomedical applications with ISO 18000-3 interface in 0.35 µm CMOS." *Sensors* 19, no. 19 (2019): 4110. 3. Vavrinský, Erik, Martin Daříček, Martin Donoval, Karol Rendek, František Horínek, Martin Horniak, and Daniel Donoval. "Design of EMG wireless sensor system." In *2011 International Conference on Applied Electronics*, pp. 1-4. IEEE, 2011. 4. Rendek, K., M. Daříček, E. Vavrinský, M. Donoval, and D. Donoval. "Biomedical signal amplifier for EMG wireless sensor system." In *The Eighth International Conference on Advanced Semiconductor Devices and Microsystems*, pp. 251-254. IEEE, 2010.
Topics relevant to "EMPLOYABILITY SKILLS" : Wireless Connectivity in Medical Instruments, Phonocardiograph (PCG) for heart sound measurement, Basics of diagnostics radiology, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3203	**Course Title:** Printed Circuit Board Design **Type of Course Discipline Elective-General Basket**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic electronics concepts					
Anti-requisites	**NIL**					
Course Description	This course will teach teams of students how to design and fabricate PCB for prototyping as well as in Industrial Production environment. This will help students to innovate faster with electronics technology.					
Course Objective	This course is designed to develop ENTREPRENEURIAL SKILLS by using EXPERIENTIAL LEARNING techniques.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Understand basics of PCB designing. 2. Apply advance techniques, skills and modern tools for designing and fabrication of PCBs. 3. Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB. 4. Understand concepts of Packaging.					

<table>
<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>7 session</td></tr>
<tr><td colspan="5">Topics:
Need for PCB, Types of PCBs Single and Multilayer, Technology: Plated Through Hole, Surface Mount, PCB Material, Electronic Component packaging, PCB Designing, Fabrication, Production, Electronic Design Automation Tools: Proprietary tools like Eagle, Ultiboard, Orcad and Opensource tools like KiCad, Design Issues: Transmission line, Cross talk and Thermal management.</td></tr>
<tr><td>Module 2</td><td>PCB Design</td><td>Assignment / Quiz</td><td>Design and Simulation task</td><td>12 session</td></tr>
<tr><td colspan="5">Topics:
Introduction to KiCad, Schematic entry / drawing, netlisting, layering, component foot print library selection & designing, design rules, component placing: Manual & automatic, track routing: automatic & manual, rules: track length, angle, joint & size, Autorouter setup. IPC standards for schematic, designing, material and documentation</td></tr>
<tr><td>Module 3</td><td>PCB Prototyping and Production</td><td>Assignment</td><td>Analysis and Verification</td><td>16 session</td></tr>
<tr><td colspan="5">Topics: PCB Prototyping: CNC Machine, Photo-Lithography process, Screen Printing process and chemical etching. PCB Mass Manufacturing Process: Gerber Generation, CAM, panelization, cleaning, drilling, plating, screen printing, etching, automated optical inspection, tinning, solder resist, legend printing, PCB testing</td></tr>
<tr><td>Module 4</td><td>PCB design for EMI/EMC</td><td></td><td>Case study</td><td>10 session</td></tr>
<tr><td colspan="5">Subsystem/PCB Placement in an enclosure, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Electronic waste; Printed circuit boards Recycling techniques,Introduction to Integrated Circuit Packaging and footprints, NEMA and IPC standards,.</td></tr>
</table>

Targeted Application & Tools that can be used:

Application: Printed circuit board (PCB) design **brings your electronic circuits to life in the physical form**. Using layout software, the PCB design process combines component placement and routing to define electrical connectivity on a manufactured circuit board **The students will be able to find career opportunities in various domains such as:**

PCB design engineer
PCB layout engineer.
Application engineer technical support.
Professionally Used Software: Altium.,Fusion 360.,Altium 365,NI Multisim,Autodesk EAGLE, KiCad EDA,Ansys RedHawk.EasyEDA.

Project Work/Assignment:

1.Case Studies: At the end of the course students will be given a PCB-HISTORY * TYPES * APPLICATIONS * ADVANTAGES * DIS-ADVANTAGES * TOP PCBs MANUFACTURERS IN INDIA * MATERIALS USED IN MANUFACTURING PCBs * MANUFACTURING PROCESS * SOLDER RESIST * TEST * PROTECTION AND PACKAGING **as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. using PCB**

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

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

4. Project Assignment:

Assignment 1: Implement simple analog circuits using KiCad.

Assignment 2: Assignment Each student was assigned a unique schematic to be drafted using MultiSim' s schematic capture feature. You should create an error-free net list, import it into the PCB feature of Ultiboard, then design a proper laid-out and routing. Designs should be no bigger than 6" x6"

Text book:

1. Printed circuit board design, fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006

Reference(s):

Reference Book(s):

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

Jon Varteresian, Fabricating Printed Circuit Boards, Newnes, 2002

2. R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill 2001

3. Mark Madou, Fundamentals of Microfabrication, CRC Press, ISBN: 0-8493-9451-1

4. Elaine Rhodes, Developing Printed Circuit Assemblies: From Specifications to Mass Production, 2008 5. C. Robertson. PCB Designer´s Reference. Prentice Hall, 2003

6. C. Coombs, Printed Circuits Handbook, McGraw-Hill Professional, 6 edition, 2007

7. V. Shukla, Signal Integrity for PCB Designers, Reference Designer, 2009

8. D. Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, 2003

9. B. Archambeault, J. Dreuiawniak, PCB Design for Real-World EMI Control, Springer, 2002

10. RS Khandpur, Printed Circuit Board, Tata McGraw Hill Education Pvt Ltd., New Delhi

11. S D Mehta, Electronic Product Design Volume-I, S Chand Publications

12. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/

13. PCB Fabrication user guide page: http://www.wikihow.com/Create-Printed-Circuit-Boards , http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication/ , http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself

14. PCB Fabrication at home(video): https://www.youtube.com/watch?v=mv7Y0A9YeUc, https://www.youtube.com/watch?v=imQTCW1yWk

E-content:

1. Andres H. Rodriguez; Daniel J. Gonzalez; Mark C. Lesak " Design of a Printed Circuit Board (PCB) for Electrical Integration on the Agile Ground Robot (AGRO)." in 2020 IEEE MIT Undergraduate Research Technology Conference (URTC). https://ieeexplore.ieee.org/document/9668875.

2. Rémy Caillaud; Cyril Buttay; Roberto Mrad; Johan Le Leslé; Florent Morel; Nicolas Degrenne; Stefan M."Design, manufacturing and characterization of printed circuit board embedded inductors for power applications" in **2018 IEEE International Conference on Industrial Technology (ICIT).** https://ieeexplore.ieee.org/document/8352262

3. Ali Toprak; Ali Rifat Boynuegri "Printed Circuit Board Rapid Prototyping with Three-Dimensional Printer" in 2020 4th *International* Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) https://ieeexplore.ieee.org/document/9254998

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

Topics related to development of "FOUNDATION": Need for PCB, Types of PCBs Single and Multilayer, Technology

Topics related to development of "EMPLOYABILITY": PCB DESIGN

Topics related to development of "ENTREPRENEURSHIP": PCB Prototyping and Production Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": PCB design for EMI/EMC. Topics related to development of "HUMAN VALUES AND PROFESSIONAL ETHICS": Application of PCB design.

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

Course Code: ECE3204	**Course Title: Electronic Controlled Converter** **Type of Course: Discipline Elective, General Basket** **Theory only**	**L-P-C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**The knowledge of analog electronics and microcontroller are needed to design the power converter and associated control circuit; and network theorems for voltage and current calculation in power converter topologies.**				
Anti-requisites	**NIL**				
Course Description	The purpose of this course is to enable the students to learn about the basics of power semiconductor devices, design of variety of power electronic converters and associated control algorithms for the control and conversion of one form of energy into another form of energy. The nature of the course is application oriented. The course benefits the students through assignment projects based on practical implementation of various power converters which will be useful in domestic and industrial applications				
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using MATLAB/Simulink or PSpice Tools.				
Course Outcomes	**On successful completion of this course the students shall be able to:** CO1: Describe the features, principles and characteristics of power semiconductor devices. (L2) CO2: Examine the working of AC to DC controlled power converters. (L3) CO3: Illustrate the operation of DC-to-DC power converters. (L3) CO4: Design DC to AC power converters for uninterruptible power supplies (UPS) and electric vehicles (EVs). (L3) CO5: Demonstrate the working of AC-to-AC power converters. (L3)				
Course Content:					
Module 1	Introduction to power electronics	Assignment	Control characteristics of power	**06 session**	

<table>
<tr><td></td><td></td><td></td><td>semiconductor devices</td><td></td></tr>
<tr><td colspan="5">Topics:
Introduction to power electronics (definition, block diagram, applications), various power semiconductor devices, control characteristics of power semiconductor devices, peripheral effects of power electronics</td></tr>
<tr><td>Module 2</td><td>AC to controlled DC power converters</td><td>Assignment</td><td>Simulation of AC to controlled DC power converter (Full bridge controlled)</td><td>10 sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to AC to controlled DC converter, single phase full bridge-controlled converter using single silicon-controlled rectifier, gating pulse generation, isolation and gate drive circuits</td></tr>
<tr><td>Module 3</td><td>DC to DC power converter</td><td>Assignment</td><td>Simulation of DC-to-DC power converter</td><td>10 sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to DC-to-DC converter, Buck converter, Boost converter, class C type bi-directional dc-dc converter, Fly-back converter, PWM pulses generation, isolation and gate drive circuits, Numerical Examples</td></tr>
<tr><td>Module 4</td><td>DC to AC power converter</td><td>Assignment</td><td>Simulation of DC to AC power converter</td><td>09 session</td></tr>
<tr><td colspan="5">Topics:
Introduction to DC to AC converter, single phase full-bridge inverter, single pulse width modulation and sine pulse width modulation, filter selection, isolation circuit and gate drive circuits, Numerical Examples</td></tr>
<tr><td>Module 5</td><td>AC to AC power converter</td><td>Assignment</td><td>Simulation of AC-to-AC power converter</td><td>09 session</td></tr>
<tr><td colspan="5">Introduction to AC to AC converter, single phase bi-directional AC voltage controller using TWO Thyristors / single TRIAC, gating signal generation, isolation and gate drive circuits, Numerical Examples.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Targeted Applications: Application Area is solar, wind, automotive, domestic and industrial etc.

Professionally Used Software: Arduino/Raspberry Pi /MATLAB/SIMULINK/Python (Anaconda / Jupiter Notebook)/PSpice</td></tr>
<tr><td colspan="5">Project Work/Assignment:</td></tr>
</table>

1.Case Studies: At the end of the course students will be given a 'real-world' application-based topics like controlled rectifiers, choppers, inverters etc. as a case study. Students will be submitting a report which will include Circuit Diagrams, Design, Working Mechanism and Results etc. in appropriate format.

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

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

4. Project Assignment: Software/Hardware implementation of few important power converters studied in this course

Assignment-1: AC to Controlled DC power converter using SCR and display the output DC voltage on LCD using Arduino controller

Assignment-2: Fixed DC to Variable DC power converter (Step-down DC-DC converter) using IGBT and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller

Assignment-3: Fixed DC to Variable DC power converter (Step-up DC-DC converter) using IGBT and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller

Assignment-4: Fixed DC to DC to multiple DC power converter (Isolated Fly-back converter) using Power MOSFET and associated components and display the input DC voltage and output DC voltage on LCD using Arduino controller

Assignment-5: AC to Controlled AC power converter (Bidirectional AC voltage controller) using TRIAC and associated components and display the output AC voltage on LCD using Arduino controller

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

Text Book(s):

1. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India Pvt. Ltd., /Pearson (Singapore -Asia) New Delhi, 2nd Edition, 2002
2. Ned Mohan, T. M. Undeland, W. P. robbins "Power Electronics: Converters, Applications and Design", John-Wiley, 3rd Edition, 2007

Reference(s):

Reference Book(s):

7. M. D. Sing and Khanchandani K. B, "Power Electronics", TMH Publishing Company Limited, 2001
8. Cyril W. Lander, "Power Electronics", McGraw Hill, 3rd Edition, 1993

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

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

8. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/   **E-content:**   5. D. Fewson, "Introduction to power electronics," in IEEE Power Engineering Review, vol. 19, no. 9, pp. 44-44, Sept. 1999, doi: 10.1109/MPER.1999.785806. https://ieeexplore.ieee.org/document/785806   6. P. Nicolae, I. Nicolae and M. Motocu, "Behavior of a fully controlled rectifier from a power group," Proceedings of 14th International Power Electronics and Motion Control Conference EPE-PEMC 2010, 2010, pp. T11-99-T11-106, doi: 10.1109/EPEPEMC.2010.5606513. https://ieeexplore.ieee.org/document/5606513   7. B. Kim, E. Boulaud, E. Boisaubert, S. Am and P. Chrin, "Study of the Control of a New AC Voltage Stabilizer using Linear Controller with Reference Frame Transformation," 2020 22nd European Conference on Power Electronics and Applications (EPE'20 ECCE Europe), 2020, pp. P.1-P.7, doi: 10.23919/EPE20ECCEEurope43536.2020.9215637. https://ieeexplore.ieee.org/document/9215637   8. R. Bououd and L. Sbita, "An overview of chopper topologies," 2017 International Conference on Green Energy Conversion Systems (GECS), 2017, pp. 1-7, doi: 10.1109/GECS.2017.8066207. https://ieeexplore.ieee.org/document/8066207   9. R. Billmeyer, M. Lu, B. Johnson and S. Dhople, "Modeling and Simulation of Power-Electronic Inverters in Analog Electronic Circuit Simulators," 2021 IEEE International Symposium on Circuits and Systems (ISCAS), 2021, pp. 1-5, doi: 10.1109/ISCAS51556.2021.9401268. https://ieeexplore.ieee.org/document/9401268
Topics related to development of "FOUNDATION SKILLS": Various power semiconductor devices and Power Converters.   Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Power Converters.

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

Course Code: ECE3205	Course Title: Industrial Automation and Control Type of Course: Discipline Elective- General Basket	L - T-P - C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Digital Control Systems (ECE3005)					

<table>
<tr><td></td><td colspan="4">Concepts of analog to digital and digital to analog conversions. To know about time response specifications of second order systems and Proportional-Integral-Derivative (PID) controllers.</td></tr>
<tr><td>Anti-requisites</td><td colspan="4">Nil</td></tr>
<tr><td>Course Description</td><td colspan="4">The purpose of this course is to enable the students to appreciate the need for Industrial Automation and control which play a key role in modern industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn the basics of automation and working of systems. The course will be supported by various simulation assignments, which will enhance the student’s abilities to become a good Industrial Automation and Control engineer.</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of Industrial Automation and Control and develop Employability Skills of the student by Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
1) Explain the need for industrial automation and basic automation components
2) Analyze industrial process parameters and control system types
3) Explain PLC and SCADA architecture and operation
4) Develop PLC programs using ladder logic for industrial applications
5) Illustrate the concepts, configuration and integration of DCS
6) Explain IoT and IIoT concepts and their industrial applications</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Industrial Automation</td><td>Assignment/ Quizzes</td><td>Data Collection and Analysis</td><td>14 Classes</td></tr>
<tr><td colspan="5">Automation components: Need for process control, Pressure to Current (P/I), current to pressure (I/P) converters, basic Control elements, open loop and closed loop control systems. Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT.

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and SCADA, Different Systems in SCADA like Field Instrumentation, Remote terminal unit (RTU), Master Terminal Unit (MTU).</td></tr>
<tr><td>Module 2</td><td>Programmable logic controllers and Relay Ladder Logic</td><td>Assignment / Quizzes</td><td>Programming and Simulation task</td><td>11 Sessions</td></tr>
<tr><td colspan="5">Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries. Relay Ladder Logic and Programming.</td></tr>
<tr><td>Module 3</td><td>Distributed Control System</td><td>Assignment</td><td>Programming and Simulation task</td><td>06 Sessions</td></tr>
</table>

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.				
Module 4	Industrial Internet of Things	Assignment	System Design Task and Analysis	08 Sessions
Introduction to Internet of Things - Overview of Internet of Things- the Edge, Cloud and the Application Development, Anatomy of the Thing, Industrial Internet of Things (IIoT – Industry 4.0), Quality Assurance, Predictive Maintenance, Real Time Diagnostics, Design and Development for IoT, Understanding System Design for IoT, Design Model for IoT.				

Targeted Application & Tools that can be used

Application Area:

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

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

Text Book(s):

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

References

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

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

1. NPTEL :: Electrical Engineering - Industrial Automation and Control
2. What is a PLC? PLC Basics Pt1 - Bing video
3. What is DCS? (Distributed Control System) - Bing video
4. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
5. https://presiuniv.knimbus.com/user#/home

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

Catalogue prepared by	Mr. Syed Abrar Ahmed Mr. Tony Aby Varkey M
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: ECE3206	Course Title: Linear Algebra for Communication Engineering Type of Course: Discipline Electivefrom General Basket & Theory only	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	To succeed in this course the student should be comfortable with vectors, matrices and their operations.					
Anti-requisites	NIL					

<table>
<tr><td>Course Description</td><td colspan="5">The course emphasizeson the applications of linear algebra in communication engineering. This course finds applications in various fields of engineering, like Signal Processing, Coding Theory, Machine Learning, Computer Graphics and Computer Vision. The course provides insights into the methods for reducing the problem from many areas of engineering into one in linear algebra extended to multi-dimensional spaces. The course also deals with techniques to solve problems analytically.</td></tr>
<tr><td>Course Objective</td><td colspan="5">The objective of the course is to familiarize the learners with the concepts of Linear Algebra for Communication Engineering and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">On successful completion of this course the students shall be able to:
CO1: Describe the fundamentals of linear algebra, including matrix operations, Gaussian elimination, and the four fundamental subspaces. (L2)
CO2: Use least squares approximation and projection matrices to solve systems of linear equations. (L2)
CO3: Employ eigenvalue and eigenvector computations to diagonalize matrices. (L3)
CO4: Examine symmetric and positive definite matrices to determine their properties and applications in optimization. (L3)
CO5: Assess the role of Singular Value Decomposition (SVD) in linear transformations and data analysis. (L3)
CO6: Solve linear programming problems using geometric and simplex methods, including duality principles. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="5"></td></tr>
<tr><td>Module 1</td><td>Matrices and Gaussian Elimination</td><td>Assignment</td><td></td><td>Programming (Curve Fitting) Task</td><td>10 Sessions</td></tr>
<tr><td colspan="6">Topics:
Introduction, the geometry of linear equations, elimination with matrices, multiplication and inverse matrices, factorization, column space and null space, Solution to homogenous equations, Row reduced form, Independence, Basis and Dimensions, the four fundamental sub-spaces, matrix spaces.</td></tr>
<tr><td>Module 2</td><td>Least squares, Determinants and Eigenvalues</td><td>Assignment</td><td></td><td>Programming Task</td><td>10Sessions</td></tr>
<tr><td colspan="6">Topics:
Orthogonal vectors and subspaces, projection onto subspaces, projection matrices and least squares, orthogonal matrices and Gram-Schmidt, properties of determinants, determinant formulas and cofactors, Cramer’s rule, eigenvalues and eigenvectors, diagonalization and powers, differential equations, Fourier Series.</td></tr>
<tr><td>Module 3</td><td>Positive Definite Matrices and Applications</td><td>Project Assignment</td><td></td><td>Programming and Simulation Task</td><td>14Sessions</td></tr>
<tr><td colspan="6">Topics:
Symmetric matrices and positive definiteness, positive definite matrices and minima, Linear transformations and their matrices, change of basis, Singular Value Decomposition, Fourier Transform, similar matrices and Jordan form.</td></tr>
<tr><td>Module 4</td><td>Optimization</td><td>Programming Task</td><td></td><td colspan="2">11 sessions</td></tr>
<tr><td colspan="6">Topics:
Matrix Games, Linear Programming–Geometric Method, Linear Programming–Simplex Method, Duality</td></tr>
<tr><td colspan="6">Targeted Applications and Tools</td></tr>
</table>

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Signal Processing	Noise reduction using projection methods	MATLAB, NumPy	Telecom, Audio Engineering
Coding Theory	Error correction using orthogonal matrices	MATLAB, Python	Telecommunications, Data Storage
Machine Learning	Principal Component Analysis (PCA) using SVD	Python, TensorFlow, Scikit-learn	AI & ML, FinTech, HealthTech
Computer Vision	Face recognition using eigenfaces	OpenCV, Python, TensorFlow	Surveillance, AR/VR, Robotics
Computer Graphics	Transformation of objects using linear maps	Blender, MATLAB, OpenGL	Gaming, Animation, Simulation
Data Science	Dimensionality reduction using SVD and matrix factorization	Python, Jupyter Notebook	Analytics, Finance, Healthcare

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Curve Fitting using Least Squares	Understand over-determined systems and data fitting	Python (NumPy, Matplotlib), MATLAB	Curve fitting, system over-determination handling
Eigenface Generation	Apply eigenvalue decomposition for image compression and recognition	Python (OpenCV, Scikit-learn), MATLAB	Image compression, pattern recognition
Orthogonalization via Gram-Schmidt	Demonstrate vector projection and basis generation	MATLAB, Python (SymPy)	Orthogonal basis construction, projection operations
Diagonalization of Matrices	Analyze linear systems and matrix powers for communication models	MATLAB, Python	Matrix analysis, eigenvalue computation
Channel Modeling in MIMO Systems	Model and simulate multi-antenna systems using linear algebra	MATLAB Simulink	MIMO simulation, channel estimation

Textbook(s):

David C. Lay, "Linear Algebra and Its Applications", (6th Edition), Pearson (2020)

References:

1. Gilbert Strang, "Introduction to Linear Algebra", 5th Edition-Wellesley Cambridge Press (2016).

2. Ron Larson, David C. Falvo, "Elementary Linear Algebra", 8th Edition- Brooks Cole (2016).

3. D.C. Lay, S.R. Lay, J.J. McDonald, "Linear algebra and its applications"

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

1. Linear Algebra | Khan Academy
2. Linear Algebra | MIT OpenCourseWare

E-content

1. Hansen Anders C. 2010 "Infinite-dimensional numerical linear algebra: theory and applications", Proc. R. Soc. A. 4663539‑3559, http://doi.org/10.1098/rspa.2009.0617 2. Calvetti, D., Reichel, L., Sgallari, F. (1999). Applications of Anti-Gauss Quadrature Rules in Linear Algebra. In: Gautschi, W., Opfer, G., Golub, G.H. (eds) Applications and Computation of Orthogonal Polynomials. International Series of Numerical Mathematics, vol 131. Birkhäuser, Basel. https://doi.org/10.1007/978-3-0348-8685-7_3 Presidency University Library Link https://presiuniv.knimbus.com/user#/home	
Topics relevant to “EMPLOYABILITY SKILLS”: Cramer’s rule, Fourier Transform for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout. Topics relevant to development of “FOUNDATION SKILLS”: Solution to homogenous equations, Basis and Dimensions, the four fundamental sub-spaces. Topics relevant to development of “EMPLOYABILITY”: Linear transformations and their matrices, Singular Value Decomposition.	
Catalogue prepared by	Dr. Robin Rohit Vincent
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

<table>
<tr><td>Course Code:
ECE3207</td><td colspan="2">Course Title: Fuzzy Logic and its Engineering Applications

Type of Course: : Discipline Elective-Signal Processing Basket</td><td>L- T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="7">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">Fuzzy Logic is an advanced topic, so the students opting for this subject should have preliminary knowledge of Set Theory, Logic, and Engineering Mathematics</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">The course is specially designed for candidates dealing with electrical, electronics, and communications engineering. The candidates can engage in the fuzzy systems theory concepts and gain an in-depth understanding of its usage in multiple domains. The course is designed to give a solid grounding of fundamental concepts of fuzzy logic and its applications. It will cover the basics of fuzzy set theory and presents different problems where one can apply this concept. In this course, students will learn how to implement fuzzy logic for problems involving uncertainties and vagueness. This course will act as a foundation course for the researchers working in different areas of science and engineering.</td></tr>
<tr><td>Course Description</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of Fuzzy Logic and its Engineering Applications to improve the learners' Employability Skills by using Participative Learning techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to

CO1 Explain the concepts of Fuzzy sets, their operations and properties.
CO2 Illustrate Fuzzification and Defuzzification with appropriate membership functions
CO3 Utilize membership functions, input output variables and connectives to fuzzy rule-based systems.
CO4 Categorize the real-time data based on Fuzzy equivalence relations
CO5 Make use of c-means clustering techniques to optimize data samples
CO6 Design fuzzy logic controllers for real-time applications</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Introduction to Fuzzy Sets Theory</td><td>Quiz</td><td colspan="4">Memory Recall based Quizzes</td><td>10 Sessions</td></tr>
<tr><td colspan="8">Topics:
Introduction, The Utility of Fuzzy Systems, Uncertainty and Information, Fuzzy sets and membership, Chance Versus Fuzziness, Fuzzy Set Operations, Properties of Fuzzy Set Operations</td></tr>
<tr><td>Module 2</td><td>Membership Functions, Fuzzification and De-fuzzifications</td><td>Assignment</td><td colspan="4">Comprehension based Quizzes and assignments; simulation with MATLAB</td><td>10 Sessions</td></tr>
<tr><td colspan="8">Topics:
Features of Membership function, Various Forms, Fuzzification, De-fuzzification to Crisp Sets, De-fuzzification to Scalars, Fuzzy (Rule-based) Systems</td></tr>
<tr><td>Module 3</td><td>Fuzzy Classification</td><td>Assignment</td><td colspan="4">Comprehension based Quizzes and assignments; simulation with MATLAB</td><td>10 Sessions</td></tr>
<tr><td colspan="8">Topics:</td></tr>
</table>

Classification by Equivalence Relations, Crisp Analysis, c-Means Clustering, Fuzzy c-means clustering, Classification metric, Hardening the Fuzzy c-Partition				
Module 4	Fuzzy Control System	Assignment	System Design Task and Analysis	10 Sessions
Topics: Control System Design Problem, Control(Decision) Surface, Assumption in a fuzzy control system design, Simple Fuzzy logic controllers, Fuzzy engineering process control, Fuzzy statistical process control				
Targeted Application & Tools that can be used: Fuzzy logic-based speech recognition, Fuzzy image search, Handwriting recognition, Fuzzy set modeling of decision making, Trainable fuzzy systems for idle speed control, Control of automatic exposure in video cameras, Humidity control in a clean room, Air conditioning systems, Washing machine timing, Microwave ovens, Vacuum cleaners, Altitude control of spacecraft, Satellite altitude control, Flow and mixture regulation in aircraft deicing vehicles, Decision-making support systems Professionally Used Software: MATLAB				

Text Book(s):

1. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley

Reference Book(s)

1. George J. KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, New Delhi,1995
2. S. Rajasekaran, G.A. Vijayalakshmi - Neural Networks and Fuzzy logic and Genetic Algorithms, Synthesis and Applications, PHI, New Delhi,2003.

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

1. Fuzzy Sets, Logic and Systems & Applications By Prof. Nishchal Kumar Verma, IIT Kanpur (NPTEL)- https://onlinecourses.nptel.ac.in/noc20_ee03/preview
2. A Beginner's course on Fuzzy Logic and it's Application (Udemy)- https://www.udemy.com/course/fuzzylogic/
3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley E-book http://home.iitk.ac.in/~avrs/ManyValuedLogic/FuzzyLogicforEngineers.pdf
4. E-book “Fuzzy Logic with Engineering Applications”, http://home.iitk.ac.in/~avrs/ManyValuedLogic/FuzzyLogicforEngineers.pdf
5. E-book “Fuzzy logic: a practical approach”, https://books.google.co.in/books?hl=en&lr=&id=3jGjBQAAQBAJ&oi=fnd&pg=PP1&dq=fuzzy+logic&ots=m2Jb2THX_r&sig=XaRwJHUguly1M8OFqXGAN02knTo&redir_esc=y#v=onepage&q=fuzzy%20logic&f=false
6. An Introduction to Fuzzy Logic Applications in Intelligent Systems https://books.google.co.in/books?hl=en&lr=&id=xbDSBwAAQBAJ&oi=fnd&pg=PA1&dq=ebook+fuzzy+logic&ots=ObXPuLUPEs&sig=cH4Wn_n9RA90TfOQH14ThtwM-3I#v=onepage&q=ebook%20fuzzy%20logic&f=false
7. E-content on Fuzzy Logic https://www.geeksforgeeks.org/fuzzy-logic-introduction/
8. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Bastian, S. Tano, T. Oyama and T. Arnould, "FATE: fuzzy logic automatic transmission expert system," *Proceedings of 1995 IEEE International Conference on Fuzzy Systems.*, 1995, pp. 5-6 vol.5, doi: 10.1109/FUZZY.1995.410015. https://ieeexplore.ieee.org/document/410015
2. Bastian, "Influencing the nonlinearity at the transition between fuzzy logic rules," *Proceedings of 1995 IEEE International Conference on Fuzzy Systems.*, 1995, pp. 1413-1418 vol.3, doi: 10.1109/FUZZY.1995.409865. https://ieeexplore.ieee.org/document/409865
3. C. Wong, "Realization of linear defuzzified output via mixed fuzzy logics," *[Proceedings 1993] Second IEEE International Conference on Fuzzy Systems*, 1993, pp. 1167-1172 vol.2, doi: 10.1109/FUZZY.1993.327349. https://ieeexplore.ieee.org/document/327349
4. R. L. de Mantaras and L. Godo, "From fuzzy logic to fuzzy truth-valued logic for expert systems: a survey," *[Proceedings 1993] Second IEEE International Conference on Fuzzy Systems*,

1993, pp. 750-755 vol.2, doi: 10.1109/FUZZY.1993.327536. https://ieeexplore.ieee.org/document/327536	
Topics relevant to "EMPLOYABILITY SKILLS" : Fuzzy Classification, Machine learning using Fuzzy Logic and Pattern Recognition, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Dr. Arvind Kumar
Recommended by the Board of Studies on	12th BOS held on 10/08/2021
Date of Approval by the Academic Council	Meeting No. 16th , Dated 23/10/2021

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	Signals and Systems (ECE2003), Digital Signal Processing (ECE3161) Basic concepts like Energy, Magnitude, Zero Crossing rate, Autocorrelation function, pole zero analysis, DFT and some basic mathematical concepts.					
Anti-requisites	NIL					
Course Description	Speech signal processing is highly relevant for engineering graduates as it equips them with essential skills for developing modern applications such as voice-enabled systems, intelligent assistants, biometrics, and human-computer interaction technologies. This course provides a comprehensive theoretical and practical understanding of speech production, perception, and processing for human-computer interaction, covering speech sound classification, speech recognition and verification algorithms, system limitations, and hands-on analysis through assignments and quizzes.					
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: CO1: Explain the basic mechanisms of human speech production and perception and their relevance to speech signal processing systems. (L2) CO2: Implement fundamental signal processing techniques like sampling, framing, and feature extraction for processing of speech signal. (L3) CO3: Examine speech signals in time and frequency domains to identify characteristics of voiced, unvoiced, and silent segments. (L4) CO4: Analyze different speech models and algorithms for speech recognition and speaker verification systems. (L4)					

	CO5: Apply speech analysis tools to process, visualize, and interpret real-world speech data. (L3) CO6: Investigate the performance, limitations, and challenges of speech processing systems in human–computer interaction applications. (L4)			
Course Content:				
Module 1	Fundamentals of Human Speech Production	Quiz	Memory Recall based Quizzes and assignments/simulation task	11 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 with MATLAB	12 Sessions
Topics: Introduction, Time dependent processing of speech, short time energy and average magnitude, short time Average zero crossing rate, Speech vs. silence discrimination using Energy and Zero Crossings, Pitch period estimation using parallel processing				
Module 3	Frequency domain methods for speech processing	Assignment	Comprehension based Quizzes and assignments; simulation with MATLAB	12 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.				

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Speech Recognition	Design voice assistant for Indian languages	Kaldi, Python, Azure	Consumer Electronics, AI
Speech Enhancement	Noise reduction in call center audio	Audacity, MATLAB	BPO, Telecom
Speaker Verification	Authenticate user with voiceprint	MATLAB, Praat	Security, Banking
Speech Synthesis	Build a text-to-speech system	Festival, Tacotron	Assistive Tech, Media

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Short-time Energy Analysis	Detect voiced/unvoiced speech	MATLAB	Voicing classification, temporal analysis
Cepstrum Computation	Identify pitch and formants	MATLAB / Python	Pitch detection, spectral formant extraction
Spectrogram Analysis	Visualize speech features	Audacity / Python	Spectral representation, time-frequency analysis
Design Speaker ID System	Build speaker verification model	Kaldi / Deep Learning	Speaker modeling, ML classification

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	L-T-P-C	3	0	0	3
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: CO1: Apply pixel-based mathematical operations to perform image analysis in real-world imaging applications. (L3) CO2: Apply image enhancement techniques, to improve image quality and feature extraction in digital imaging applications. (L3) CO3: Apply image restoration and image segmentation techniques to enhance image quality and extract meaningful information for imaging applications. (L3)					

	CO4: Apply image compression techniques to optimize data storage and transmission while balancing information preservation and data reduction in imaging applications. (L3) CO5: Analyze color image processing and multiresolution techniques to extract and interpret image features at different scales in imaging applications. (L4) CO6: Analyze morphological operations to enhance image structures and support effective digital image interpretation in imaging applications. (L4)				
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 sessions
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 restoration process- Fundamentals of Image Compression - Image Compression Model-Huffman coding. Fundamentals of Image Segmentation - Point, Line and Edge detection. Introduction to Unsupervised learning models used for feature extraction					
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. Introduction to Supervised learning models to Image detection and classification					

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilized	Relevant Industries
Medical Imaging	Extract tumor boundaries from MRI scans using segmentation	MATLAB, Python (OpenCV)	Healthcare, Diagnostics
Surveillance & Security	Motion detection and object tracking in CCTV footage	MATLAB, Python, Deep Learning	Security, Law Enforcement
Autonomous Vehicles	Lane and sign detection in road images	Python, TensorFlow	Automotive, Robotics
Media & Entertainment	Face detection and feature enhancement in selfies	OpenCV, Keras	Social Media, AR/VR
Remote Sensing	Satellite image classification and road extraction	MATLAB, PyTorch	Urban Planning, Defense

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Image Acquisition and RGB Manipulation	Extract and manipulate image color channels	MATLAB	Image channel analysis, metadata extraction
Logical Operations and Watermarking	Apply logical operators and implement watermarking	MATLAB	Digital watermarking, logical image operations
Histogram Computation and Equalization	Analyze and enhance contrast	MATLAB	Histogram processing, contrast enhancement
Image Restoration	Remove noise and reconstruct images	MATLAB	Noise filtering, image restoration

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.):

Reference(s):

Reference Book(s):

4. Y. Wang, J. Ostermann, and Y.Q. Zhang, "Video Processing and Communications,", Prentice Hall, First Edition
5. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach," Prentice Hall; First Edition
6. 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
5. Video lectures on "Digital Image Professing" by Prof. Dr. P K Biswas, IIT Kharagapur.
https://freevideolectures.com/course/2316/digital-image-processing-iit-kharagpur
6. https://www.coursera.org/learn/digital
7. https://nptel.ac.in/courses/117/105/117105135/

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 Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Smart Communication Systems	Adaptive Channel Equalization	MATLAB, Python	Telecom, 5G/6G
Audio Processing	Noise Cancellation	Librosa, Audacity	Consumer Electronics
Biomedical Signal Processing	ECG/EEG Denoising	Python, MATLAB	Healthcare Devices

IoT & Smart Devices	Signal Cleaning in IoT Sensors	MATLAB, PyTorch	Embedded Systems

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
LMS Filter Design	Understand gradient-based adaptive learning	Python / MATLAB	LMS convergence and step-size tuning
Wiener Filter Simulation	Noise reduction in speech signals	MATLAB Toolbox	Minimum error estimation
AR Modeling	Analyze stochastic processes	Python (statsmodels)	Stochastic modeling, AR coefficient estimation
EMD-based Filter	Explore modern decomposition techniques	PyEMD Library	Signal decomposition, noise separation

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: CO1: Explain the origin, characteristics, and physiological significance of biomedical signals including ECG, EEG, and EMG. (L2) CO2: Describe the principles and functioning of bioelectrical signal acquisition systems and their clinical relevance. (L2) CO3: Apply analog and digital filtering techniques for noise and artifact removal in biomedical signals. (L3) CO4: Analyze biomedical signals using time-domain methods for feature extraction and event detection. (L4) CO5: Analyze biomedical signals using frequency-domain methods and spectral estimation techniques. (L4) CO6: Evaluate and compare parametric signal models (AR, ARMA) for biomedical system modeling. (L5)					
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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Cardiac Monitoring	QRS Detection from ECG	Python, MATLAB	Healthcare Devices
Brain-Computer Interface	EEG Signal Processing	MNE, LabVIEW	Neurotech
Wearables	PPG Feature Extraction	Python (NeuroKit2)	Consumer Health
IoMT	Remote Biosignal Transmission	MATLAB, SciPy	Digital Health

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
ECG Feature Extraction	Identify PQRST segments	Pan-Tompkins Algorithm (MATLAB)	ECG signal segmentation and feature labeling
EEG Classification	Detect epileptic seizure	Wavelet + SVM (Python)	EEG pattern classification using ML
Denoising EMG	Remove noise from EMG signals	ICA (MATLAB/Python)	Artifact removal, clean signal reconstruction
PPG Analysis	Estimate heart rate variability	NeuroKit2 Toolkit	HRV analysis, PPG interpretation

Textbook(s):

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

Reference(s): 1. Devasahayam S. R., "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling", Kluwer Academic/Plenum Publishers, 5th edition, New York, 2000. 2. Reddy D. C., "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005. 3. Rangayyan R. M. "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002. Online Resources (e-books, notes, ppts, video lectures etc.): 1. MIT Open Course Ware Lecture Notes on "Biomedical Signal and Image Processing". https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/pages/lecture-notes/ 2. Prof. Sudipta Mukhopadhyay NPTEL Lecture Notes and Videos: https://nptel.ac.in/courses/108105101 3. Fatemeh Hadaeghi Lecture Notes (from Jacobs University Bremen): https://www.ai.rug.nl/minds/teaching/courses/t2018biomed/ 4. Dr. Kunal Pal's Video lectures on "Biomedical Signal Processing" from NIT Rourkela: https://www.youtube.com/watch?v=XKoGk99ktf8 5. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: 1. M. L. Ahlstrom and W. J. Tompkins, "Digital Filters for Real-Time ECG Signal Processing Using Microprocessors," in *IEEE Transactions on Biomedical Engineering*, vol. BME-32, no. 9, pp. 708-713, Sept. 1985, doi: 10.1109/TBME.1985.325589. https://ieeexplore.ieee.org/abstract/document/4122146 2. Coté, Gerard L., Ryszard M. Lec, and Michael V. Pishko. "Emerging biomedical sensing technologies and their applications." *IEEE Sensors Journal* 3, no. 3 (2003): 251-266. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.415.7820&rep=rep1&type=pdf 3. James, Christopher J., and Christian W. Hesse. "Independent component analysis for biomedical signals." *Physiological measurement* 26, no. 1 (2004): R15. <https://iopscience.iop.org/article/10.1088/0967-3334/26/1/R02/meta> Available at Link: https://www.academia.edu/download/49895521/0967-3334_2F26_2F1_2Fr0220161026-21959-1bfp9y3.pdf 4. Addison, Paul S. "Wavelet transforms and the ECG: a review." *Physiological measurement* 26, no. 5 (2005): R155. https://people.uwec.edu/walkerjs/primer/Papers/Addison_EEG_Review.pdf 5. Moraes, Jermana L., Matheus X. Rocha, Glauber G. Vasconcelos, José E. Vasconcelos Filho, Victor Hugo C. De Albuquerque, and Auzuir R. Alexandria. "Advances in photopletysmography signal analysis for biomedical applications." *Sensors* 18, no. 6 (2018): 1894. https://www.mdpi.com/1424-8220/18/6/1894/pdf
Topics relevant to "EMPLOYABILITY SKILLS": Analysis of ECG / EMG / EEG signals, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms. Natya.S
Recommended by the Board of Studies on	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	L- T-P-C	3		0	3

	Type of Course: Discipline Elective from Signal Processing Basket & Theory only			0		
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

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Video Streaming	Live encoding of H.264 video	FFmpeg, OpenCV	OTT Media, Surveillance
Speech Enhancement	Noise reduction for VoIP	MATLAB, Python	Telecom, Assistive Tech
Image Compression	JPEG2000 encoder design	Python (PyWavelets)	Medical Imaging, Drones
Music Processing	Spectral separation of instruments	Librosa, Jupyter	Music Tech, DSP

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Implement Huffman & LZW	Understand lossless coding	Python, custom scripts	Entropy coding, data compression
Design MPEG-4 Encoder	Comprehend video compression	FFmpeg, OpenCV	Video coding pipeline setup
Speech Enhancement Filter	Reduce ambient noise	MATLAB, SciPy	Signal filtering, speech enhancement
Build JPEG Compressor	Master image compression	Python, PIL, PyWavelets	JPEG compression, wavelet analysis

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 banks	Assignment/Quiz	Theoretical Understanding	10 Sessions
Topics: *M*-channel linear phase filter banks, Multiresolution analysis and wavelet theory, Comparison of wavelet and Fourier transform,				
Module 3	Filter banks and discrete wavelet transform	Assignment/Quiz	Theoretical Understanding	11 Sessions
Topics: Wavelet with FIR and IIR filters I, Wavelet with FIR and IIR filters II, *M*-band wavelet, Wavelet design based on cosine modulated filter banks, Wavelet transform application: de-noising and compression, Matching wavelet.				

Targeted Application & Tools that can be used:

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

Professionally Used Software:

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

Project work/Assignment:

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

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

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

Text Book(s):

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks. Prentice-Hall. Englewood Cliffs, NJ: 1993.

2. G. Strang and T. Q. Nguyen, Wavelets and Filter Banks. Wellesley-Cambridge Press, Wellesley, MA, Revised Edition, 1998. 3. Stephane Mallat, A Wavlet Tour of Signal Processing. San Diego: Academic Press, 1999.
Reference(s): 1. M. Vetterli and J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, Englewood Cliffs, NJ, 1995. 2. Fusheng Yang, Engineering Analysis and Applications of Wavelet Transform. Science Press, BJ:1999.
Online Resources (e-books, notes, ppts, video lectures etc.): 1. NPTEL :: Electrical Engineering - NOC:Fundamentals of Wavelets, Filter Banks and Time Frequency Analysis 2. Lecture Notes | Wavelets, Filter Banks and Applications | Mathematics | MIT OpenCourseWare 3. Introduction to Wavelet.ppt (live.com)
E-content: 1. P. P. Vaidyanathan, "Multirate digital filters, filter banks, polyphase networks, andapplications: a tutorial", *Proc. IEEE*, vol. 78, no. 1, pp. 56-93, January 1990. 2. P. P. Vaidyanathan, "Theory and design of *M*-channel maximally decimated quadrature mirror filters with arbitrary *M,* having the prefect reconstructions property," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. 35, no. 4, pp. 476-492, April 1987. 3. R. D. Koilpillai and P. P. Vaidyanathan, "Cosine-Modulated FIR Filter Banks Satisfying Perfect Reconstruction," *IEEE Trans. Signal Processing,* vol. 40, no. 4, April 1992. 4. T.Q.Nguyen, "Near Perfect Reconstruction *Pseudo*-QMF Banks," *IEEE Trans. Signal Processing,* vol. 42, no. 1, pp. 65-76, January 1994. 5. T. Q. Nguyen, "A tutorial on Filter Banks and Wavelets," I*n Proc. IEEE International Conference on Digital Signal Processing,* Cypress, June 1995. 6. Y. P. Lin and P. P. Vaidyanathan, "Linear Phase Cosine Modulated Maximally Decimated Filter Banks with Perfect Reconstruction," *IEEE Trans. Signal Processing*, vol. 42, no. 11, November 1995.

Catalogue prepared by	Ms. Swetha G
Recommended by the Board of Studies on	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					

<table>
<tr><td>Course Description</td><td colspan="4">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.</td></tr>
<tr><td>Course Objective</td><td colspan="4">This course is designed to improve the learners' <u>EMPLOYABILITY SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques using open source Design Tools.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">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.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Probability Theory and Probability Statistics</td><td>Assignment</td><td>Problem Solving Task</td><td>7 Sessions</td></tr>
<tr><td colspan="5">Topics:
Probability models and axioms, Conditioning and Bayes' rule, Independence, Counting</td></tr>
<tr><td>Module 2</td><td>Random Variables</td><td>Assignment</td><td>Problem Solving Task</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 3</td><td>Distribution Functions and Random Processes</td><td>Assignment</td><td>Problem Solving Task</td><td>11 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Detection, estimation and filtering</td><td>Assignment</td><td>Problem solving task</td><td>17 sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">Project work/Assignment:</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">Textbook(s):
1. Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2nd Edition, Wiley, 2016</td></tr>
</table>

2. Mourad Barkat, "Signal detection and estimation", 2e, Artech House, 2005
References: 1. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability. 2nd ed. Athena Scientific, 2008. ISBN: 9781886529236. 2. Athanasios Papoulis and S. Unnikrishnan Pillai, "Probability, Random Variables and Stochastic Processes", 4th edition, PHI, 2002. 3. Henry Stark and John W. Woods, "Probability and Random Processes with Application to Signal Processing", 3rd edition, Pearson Education, 2009 Online Resources (e-books, notes, ppts, video lectures etc.): **1.** Probabilistic Systems Analysis and Applied Probability (amser.org) **2.** Introduction To Applied Probability | Udemy **3.** Probability Theory and Stochastic Processes with Applications **4.** Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content **1.** https://www.researchgate.net/publication/309793344_Reliability_sensitivities_with_fuzzy_random_uncertainties_using_genetic_algorithm **2.** https://www.researchgate.net/publication/333449747_Methodologies_for_Assessing_Risks_of_Accidents_in_Chemical_Process_Industries **3.** https://www.researchgate.net/publication/226742073_Modelling_Technologies_and_Applications **4.** https://www.researchgate.net/publication/327826061_Modelling_Technologies_and_Applications_Nanotechnologies_and_Electronics_Packaging
Topics relevant to development of "Foundation Skills" : Probability models and axioms; probability mass functions; expectations. Topics relevant to development of "Employability" : Markov chains; Central limit theorem, Bayesian statistical inference.

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

Course Code: ECE3407	Course Title: Video Processing and Computer Vision Type of Course: : Discipline Elective- Signal Processing Basket	L-T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Image Processing, Signals and Systems, Transforms and Techniques					
Anti-requisites	NIL					

<table>
<tr><td>Course Description</td><td colspan="4">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="4">This course is designed to improve the learner's <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> Methodologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">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="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Video Processing</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>09 session</td></tr>
<tr><td colspan="5">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>Video Processing</td><td>Assignment / Quiz</td><td>Programming and Simulation task / Memory Recall based Quizzes</td><td>12 session</td></tr>
<tr><td colspan="5">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>
<tr><td>Module 3</td><td>Introduction to Computer Vision and Algorithms</td><td>Assignment</td><td>Programming Assignment</td><td>12 session</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 4</td><td>Applications of Computer Vision</td><td>Assignment</td><td>Programming Assignment</td><td>12 session</td></tr>
<tr><td colspan="5">Topics:
Object detection and tracking various scenarios, Pattern Analysis, Face recognition and Tracking, Applications of computer vision in robotics and Autonomous Vehicles (ADAS)</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Targeted Applications: Security and Surveillance, ADAS, Industry 4.0</td></tr>
</table>

Professionally Used Software: Python/ MATLAB/ SCILAB
Project Work/Assignment:
1. Case Study: At the end of the course students will be given a 'real-world' application-based on Computer Vision and Video Processing as a case study. Students will be submitting a brief report in appropriate format 2 Article review: At the end of the course a literature review of any 01 recent articles from the reputed national and international journal/ conferences will be given by students. They need to refer to tools like Scopus/ Google-Scholar and submit a report on their understanding of the assigned article in appropriate format. 3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to present their review work.
Text Book(s): 2. AL BOVIK, "Handbook of Image and Video Processing," Elsevier Science, 2nd Edition. 3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011, 1st Edition.
Topics relevant to the: "FOUNDATION SKILLS", Introduction to Computer Vision, , Image Processing VS Computer 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 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

VLSI 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					

<table>
<tr><td>Course Description</td><td colspan="4">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.</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
CO1. Describe the design methodology and performance parameters of VLSI systems
CO2. Analyze architectural building blocks such as ALUs, multipliers, and memory subsystems.
CO3. Apply VLSI architecture concepts in real-world applications such as DSP, AI accelerators, and embedded systems.
CO4. Evaluate performance, power, and area trade-offs using architectural-level optimization techniques.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to VLSI Architecture and Design Metrics</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>09 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 2</td><td>Datapath Architectures and Arithmetic Units</td><td>Assignment</td><td></td><td>12 Session</td></tr>
<tr><td colspan="5">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
.</td></tr>
<tr><td>Module 3</td><td>Pipelining, Parallelism, and Instruction-Level Optimization</td><td>Assignment</td><td>Theoretical Understanding</td><td>14 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Memory Architectures</td><td>Assignment</td><td></td><td>10 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Applications: ASIC design, SoC architecture, AI and DSP processors, FPGA-based embedded systems</td></tr>
</table>

Tools: Xilinx Vivado, Synopsys Design Compiler, Cadence Genus, ModelSim, Verilog/SystemVerilog, RTL simulation
Text Book 3. David A. Patterson and John L. Hennessy, Computer Organization and Design – The Hardware/Software Interface, Morgan Kaufmann, 2017.
Reference(s): Reference Books 11. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd ed., Pearson, 2003. 12. 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: 7. William Cheng-Yu Ma;Yan-Jia Huang;Po-Jen Chen;Jhe-Wei Jhu;Yan-Shiuan Chang;Ting-Hsuan Chang ,"Impacts of Vertically Stacked Monolithic 3D-IC Process on Characteristics of Underlying Thin-Film Transistor" , IEEE Journal of the Electron Devices Society 2020 , https://ieeexplore.ieee.org/document/9141258 8. 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 9. 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					

<table>
<tr><td>Course Description</td><td colspan="4">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</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
CO1. Describe architecture of programmable devices.
CO2. Explain programmable methodologies.
CO3. Relate design and implementation flow for PLDs.
CO4. Explain the low power design techniques and methodologies.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to ASICS, CMOS LOGIC, ASIC Library Design</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>09 Session</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Programmable ASICS</td><td>Assignment</td><td></td><td>12 Session</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>Low Level Design</td><td>Assignment</td><td>Theoretical Understanding</td><td>14 Session</td></tr>
<tr><td colspan="5">Topics:
Entry: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Log</td></tr>
<tr><td>Module 4</td><td>Silicon On Chip Design</td><td>Assignment</td><td colspan="2">10 Session</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">Text Book
4. M.J.S. Smith, ―Application Specific Integrated Circuits‖, Pearson Education, 2008 .</td></tr>
<tr><td colspan="5">Reference(s):
Reference Books
13. Wayne Wolf, ―FPGA-Based System Design‖, Prentice Hall PTR, 2009.
14. 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:
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</td></tr>
</table>

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": 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: ECE3457	**Course Title: Semiconductor Device Modeling** **Type of Course: Discipline Elective, General Basket** **Theory only**		**L-T-P-C**	3	0	3
Version No.	1.0					
Course Pre-requisites	Engineering Physics, Electron devices					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the theoretical concepts of various semiconductor devices. The course also demonstrates the use of Cadence / Micro wind / other EDA tools to design various circuit designs for different applications.					
Course Objective	This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using VLSI Design Tools.					
Course Outcomes	On successful completion of this course, the students shall be able to: CO1. Describe the properties of MOS capacitors CO2. Understand the various characteristics of the MOSFET device CO3. Illustrate the design of CMOS design parameter and their impact on its performance CO4. Analyze the various SPICE models of semiconductor devices					
Course Content:						
Module 1	**MOS capacitors**	Quiz	Memory Recall-based Quizzes	**12 sessions**		
Topics: Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in a MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling.						

Module 2	**MOSFET devices**	Assignment / Quiz	Memory Recall-based Quizzes	**12 sessions**

Topics:
Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances, and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields.

Module 3	**CMOS device design**	Assignment	Simulation task	**12 sessions**

Topics:
CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

Module 4	**SPICE Models**	Assignment	Memory Recall-based Quizzes	**09 sessions**

Topics:
SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2, and Level 3 model, Model parameters; SPICE models of p-n diode and BJT.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:
Targeted Applications: control applications, telecommunications, high-performance computing, and consumer electronics etc.
Professionally Used Software: Cadence, Microwind, and other EDA tools

Project Work/Assignment:
1. Quiz: At the end of the course quiz topic will be given to individual students. They need to do it CAMU online portal.
2. Project Assignment: - Implementation of various design in Nonscaling using EDA tools.

Text Book(s):
7. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
8. 2. A.B. Bhattacharyya "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd, 2009.

Reference(s):
Reference Book(s):
9. C. C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson Education, 2010.
10. R. S. Muller and T. I. Kamins, Device Electronics for Integrated Circuits, 3rd Edition, Wiley India, 2009.
11. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, 3rd Edition, Wiley India, 2010.
12. Y. Tsividis, Operation and Modeling of the MOS transistor, 2nd Edition, TMH, 1999.
13. S. A. Neamen and D. Biswas, Semiconductor Physics and Devices, 4th Edition, TMH, 2012.

Online Resources (e-books, notes, ppts, video lectures etc.):
9. Free online self-paced course:- https://www.classcentral.com/course/youtube-electronics-semiconductor-device-modeling-47587
10. Online notes:- https://www.tutorialsduniya.com/notes/semiconductor-devices-notes/
11. NPTEL online video content:- https://nptel.ac.in/courses/117106033
12. Online ppts:- https://www.slideserve.com/anneke/modelling-simulation-of-semiconductor-devices
13. https://presiuniv.knimbus.com/user#/home

E-content:

9. Manikandan, M., Nirmal, D., Ajayan, J., Arivazhagan, L., Prajoon, P., Dhivyasri, G., Jagadeeswari, M. “Physics based modeling of AlGaN/BGaN quantum well based ultra violet light emitting diodes” (2022) Optical and Quantum Electronics, 54 (3), art. no. 168. https://link.springer.com/article/10.1007/s11082-022-03552-8
10. Ajayan, J., Nirmal, D., Kurian, D., Mohankumar, P., Arivazhagan, L., Augustine Fletcher, A. S., ... & Saravanan, M. (2019). Investigation of impact of gate underlap/overlap on the analog/RF performance of composite channel double gate MOSFETs. Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena, 37(6), 062201. https://pubs.aip.org/avs/jvb/article-abstract/37/6/062201/103400/Investigation-of-impact-of-gate-underlap-overlap?redirectedFrom=fulltext
11. Lenus, C. R., Haris, M., Rani, C. S. H., Samuel, T. A., & Ajayan, J. (2023). A Non-linear Circuit Model for Silicon Tunnel Field-Effect Transistors. Journal of Electronic Materials, 1-8. https://link.springer.com/article/10.1007/s11664-023-10447-1
12. Nirmal, D., & Ajayan, J. (2022). Negative Capacitance Field Effect Transistors for Future Low Power Electronics. In Low-Dimensional Nanoelectronic Devices (pp. 317-350). Apple Academic Press. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003277378-12/negative-capacitance-field-effect-transistors-future-low-power-electronics-nirmal-ajayan

- Topics related to the development of “FOUNDATION”: Surface Potential, Capacitances in a MOS Structure.
- Topics related to the development of “EMPLOYABILITY”: Extraction of Channel Length by C–V Measurements, SPICE model.

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

Course Code: ECE3459	**Course Title: Static Timing Analysis** **Type of Course: Discipline Elective- VLSI and Embedded Systems Basket**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Basic concepts of Digital Circuits, VLSI Design					
Anti-requisites	**NIL**					
Course Description	**The purpose of this course is to enable the students to understand the theoretical concepts of timing analysis in digital circuits. Static Timing Analysis is one of the important processes in ASIC design flow. By performing Static Timing Analysis, the designer can ensure that the design is meeting the timing requirements and it is working at the required clock frequency without setup and hold time violations.**					
Course Objective	**This course is designed to improve the learner's EMPLOYABILITY SKILLS by using PROBLEM SOLVING Methodologies.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** CO1. **Describe** the basics of static timing analysis CO2. **Understand** the resources required for static timing analysis CO3. **Illustrate** variants of noise and cross talk CO4. **Apply** the timing analysis concepts in real time circuits.					
Course Content:						

Module 1	**Fundamentals of Timing analysis**	Quiz	Memory Recall based Quizzes	**12 session**

Topics:
Basics of timing concepts- Propagation delay, slew, timing arcs, min and max timing paths, clock domains, Types of Delays in Digital Circuits, Different Cause for Delay, Timing Parameters for Combinational Logic Gates, Timing Parameters for Sequential Circuits, Concept of Delay Path in a Design, Clock Concepts, timing path groups, modeling of external attributes, virtual clocks, refining the timing analysis, point-to-point specification

Module 2	**Resources for Static Timing Analysis**	Assignment / Quiz	Programming task	**12 session**

Topics:
Resources for Static Timing Analysis Flow: Libraries, Netlist, Parasitics for Delay Calculation: Device Parasitics, Interconnects, Parasitic Extraction Formats, linear v/s. non-linear delay model. Clock Network Optimization: Metrics, clock skew-scheduling, handling variability. Parallel Timing Optimization: Circuit partitioning for independent timing regions. Post-Silicon Timing Validation: Introduction, sources of post-silicon timing failure, post-silicon tuning

Module 3	**Noise and Cross talk**	Assignment	Memory Recall based Quizzes	**10 session**

Topics:
Concepts of Noise and Crosstalk for static timing Analysis: Coupling Capacitance Concept, Type of Crosstalk Noise or Glitch, Types of Crosstalk Delta Delay, Noise Libraries, Crosstalk Effect on Timing Analysis, Strategy of Crosstalk on Nanometer Design: Cause for Crosstalk on Integrated Circuits, Crosstalk Prevention Methods

Module 4	**Constraints of STA**	Assignment	Programming task	**09 session**

Topics:
Constraints for STA: Clock Constraints, Other Timing Constraints, 5.2.2 External Delays of DUA, Timing Exceptions: Multicycle Path, False Path, Clock Grouping, Case Analysis, Disable Timing, Path with Derate

List of Laboratory Tasks: Nil

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

Project Work/Assignment:

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

3. Project Assignment: - Implementation of various concepts of timing analysis using cadence.

Text Book(s):

9. R.Jayagowri, Pushpendra S. Yadav, "Static Timing Analysis for VLSI circuits", MEDTECH, A Division of Scientific International, 2018.
10. J. Bhasker, R. Chadha, "Static Timing Analysis for Nanometer Designs: A Practical Approach", Springer, 2009, ISBN: 978-0-387-93819-6, 978-0-387-93820-2(e-book)

Reference(s):
Reference Book(s):

14. Sridhar Gangadharan and Sanjay Churiwala, "Constraining Designs for Synthesis and Timing Analysis - A Practical Guide to Synopsys Design Constraints (SDC)",Springer Science + Business Media, LLC, Library of Congress Cataloging-in-Publication Data, 2013, ISBN:978-1-4614-3268-5, 978-1-4614-3269-2 (eBook).
15. Jeong T.K, David O, "Digital Timing Macro modeling for VLSI Verification", Springer Science + Business Media, LLC, Library of Congress Cataloging-in-Publication Data, 1995, ISBN: 978-1-4613-5982-1, 978-1-4615-2321-5 (eBook).

16. Naresh Maheshwari and Sachin S. Sapatnekar, "Timing Analysis and Optimization of Sequential Circuits", Springer Science + Business Media, LLC, Library of Congress Catalogingin-Publication Data, 1999, ISBN:978-1-4613-7579-1, 978-1-4615-5637-4 (eBook). **Online Resources (e-books, notes, ppts, video lectures etc.):** 14. Free online self-paced course :- https://open.cs.uwaterloo.ca/static analysis-from-scratch/ 15. Online notes :- https://open.cs.uwaterloo.ca/timinganalysis-independent-lessons/ 16. NPTEL online video content:- http://www.digimat.in/nptel/courses/video/106117202/L02.html 17. Online ppts :- https://cs.antloo.ca/~mli/vlsi-static-2017-Lecture5timing.ppt 18. Online ppts:- https://www.ucns.hw.ac.uk/~dwcorne/Timing/introdl.ppt 19. https://presiuniv.knimbus.com/user#/home **E-content:** 13. E. Hu, G. Bernat and A. Wellings, "A static timing analysis environment using Java architecture for safety critical real-time systems," Proceedings of the Seventh IEEE International Workshop on Object-Oriented Real-Time Dependable Systems. (WORDS 2002), San Diego, CA, USA, 2002, pp. 77-84, doi: 10.1109/WORDS.2002.1000039. https://ieeexplore.ieee.org/document/1000039 14. X. Zhou, Y. Zhou and Y. Ma, "Static Error Mechanism Analysis and Simulation Research Based on PI Control," 2019 IEEE International Conference on Mechatronics and Automation (ICMA), Tianjin, China, 2019, pp. 58-63, doi: 10.1109/ICMA.2019.8816554. https://ieeexplore.ieee.org/document/8816554 15. Jin Wook Kim, Wook Kim, H. S. Park and Young Hwan Kim, "Incremental statistical static timing analysis with gate timing yield emphasis," APCCAS 2008 - 2008 IEEE Asia Pacific Conference on Circuits and Systems, Macao, China, 2008, pp. 1016-1019, doi: 10.1109/APCCAS.2008.4746197. https://ieeexplore.ieee.org/document/4746197 16. Y. Shi, H. Bağcı and M. Lu, "On the Static Loop Modes in the Marching-on-in-Time Solution of the Time-Domain Electric Field Integral Equation," in IEEE Antennas and Wireless Propagation Letters, vol. 13, pp. 317-320, 2014, doi: 10.1109/LAWP.2014.2305716. https://ieeexplore.ieee.org/document/6737267
Topics Relevant to development of "FOUNDATION SKILLS": Delay models and types. Topics Relevant to development of "EMPLOYABILITY": Timing constraints.

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

Course Code: 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					

<table>
<tr><td>Course Description</td><td colspan="4">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.</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course is to familiarize the learners with the concepts of ASIC Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:
CO1. Describe the computational complexity and constraints of VLSI design problems.
CO2. Apply graph-theoretic and geometric algorithms in layout synthesis.
CO3. Analyze and optimize placement, partitioning, and routing techniques.
CO4. Evaluate performance, area, and power trade-offs using algorithmic models.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to VLSI Design Automation</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>09 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 2</td><td>Partitioning, Floor planning, and Placement</td><td>Assignment</td><td></td><td>12 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 3</td><td>Global and Detailed Routing Algorithms</td><td>Assignment</td><td>Theoretical Understanding</td><td>14 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Logic Synthesis and Testing Algorithms</td><td>Assignment</td><td></td><td>10 Session</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td colspan="5">Text Book
4. Naveed A. Sherwani, Algorithms for VLSI Physical Design Automation, Springer, 2002.
5. Charles Roth and Lizy Kurian John, Digital Systems Design Using VHDL, Cengage, 2017.</td></tr>
<tr><td colspan="5">Reference(s):</td></tr>
</table>

Reference Books 15. Sadiq M. Sait and Habib Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 1999. 16. 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: 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": 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: ECE3462	Course Title: Low Power VLSI Design Type of Course: Discipline Elective and 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. Fundamentals of Analog and Digital VLSI design					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to understand the fundamentals of low power VLSI architectures and systems. The course insights into the various methods used to confront the low power issue VLSI system from circuit level to system level of abstraction. This course enhances student's abilities to develop a low power design architecture and analysis of various parameters.					

Course Objective	The objective of the course is to familiarize the learners with the concepts of Low Power VLSI Design and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the sources of power dissipation in CMOS integrated circuits. 2. Illustrate different approaches of Low power design at circuit level. 3. Summarize issues in Low Power Design at circuit and logic levels. 4. Explain leakage sources and reduction techniques.

Course Content:

Module 1	Device & Technology Impact on Low Power	Assignment/Quiz	Designing and Analysis task	10 Sessions

Topics:
Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches.

Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

Module 2	Power analysis	Assignment/Quiz	Simulation and analysis task	10 Sessions

Topics:
Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

Module 3	Low Power Design at circuit and logic level	Assignment/Quiz	Design Analysis	10 Sessions

Topics:
Low Power Design Circuit Level: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library.

Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.

Module 4	Leakage Power minimization Approaches, Adiabatic switching, 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.

Textbook(s):
1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI circuit design", John Wiley & Sons Inc., 2000. 1st Edition

References:

Reference Book(s): 1. G.K.Yeap, Farid N.Najm, "Low Power VLSI design and technology", World Scientific Publishing, 1996. (1st Edition) 2. Soudris, Dimitrios, Christrian Pignet, Goutis, Costas, "Designing CMOS circuits for low power," Springer International, 2004. (1st Edition) 3. Ajit Pal, ―Low-Power VLSI Circuits and Systems‖, Springer, 2015. (1st Edition) 4. A. P. Chandrakasan, R.W. Broderson, "Low Power Digital VLSI Design", IEEE Press, 1998. (1st Edition) 5. Gary K.Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 1998. (1st Edition) 6. Jan M. Rabaey, Massoud Pedram, "Low power Design methodologies", Kluwer Academic Press, 1996. (1st Edition) 7. Michael Keating, David Flynn "Low Power Methodology Manual for System-On-Chip Design" Springer Publication 2007. (1st Edition) Online Resources (e-books, notes, ppts, video lectures etc.): 1. Lecture videos for Low Power VLSI Circuits & Systems by Prof. Ajit Pal, IIT Kharagpur – NPTEL https://nptel.ac.in/courses/106/105/106105034/ 2. PPT on Low Power VLSI Design, Link : https://nijwmwary.com/low-power-vlsi-circuits-systems/ 3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: 1. Shanbhag, Naresh R. "Algorithms transformation techniques for low-power wireless VLSI systems design." *International Journal of Wireless Information Networks* 5, no. 2 (1998): 147-171. https://link.springer.com/article/10.1023/A:1018869519651 2. H. O. Elwan and A. M. Soliman, "Low-voltage low-power CMOS current conveyors," in IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications, vol. 44, no. 9, pp. 828-835, Sept. 1997, doi: 10.1109/81.622987. 3. C. Park, Y. A. Tavares, J. Lee, J. Wo and M. Lee, "5th-Order Continuous-Time Low-Pass Filter Achieving 56 MHz Bandwidth 30.5 dBm IIP3 With a Novel Low-Distortion Amplifier," in IEEE Transactions on Circuits and Systems II: Express Briefs, vol. 68, no. 6, pp. 1768-1772, June 2021, doi: 10.1109/TCSII.2020.3039247. 4. Carvajal, R., Torralba, A., Tombs, J. *et al.* Low Voltage Class AB Output Stage for CMOS Op-Amps Using Multiple Input Floating Gate Transistors. *Analog Integrated Circuits and Signal Processing, springer,* 36, 245–249 (2003). https://doi.org/10.1023/A:1024774506261
Topics relevant to "EMPLOYABILITY SKILLS": Probability & frequency, probabilistic power analysis techniques - for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

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

Course Code: ECE3415	Course Title: Design for Testability Type of Course: Discipline Elective and theory only	L- T-P-C	3	0	0	3
Version No.	1.0					
Course Pre-requisites	Digital Electronics, VLSI Design					
Anti-requisites	NIL					

Course Description	This course provide an in-depth theory and practice of fault analysis, test generation, and design for testability for digital VLSI circuits and systems. Introduction to design and manufacturing defect models. In addition, 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 introduced.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Design for Testability and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.				
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Explain the importance of VLSI testing, test generation and test technology. (L2) CO2: Determine the controllability and observability of VLSI circuits through testability measures for reliability of testing. (L3) CO3: Use scan designs and scan architectures to improve the testability of VLSI circuits. (L3) CO4: Apply fault models, fault classes, and test pattern generation techniques for testing VLSI circuits. (L3) CO5: Examine test generation algorithms to identify faults in digital circuits. (L4) CO6: Employ Built-In Self-Test (BIST) techniques to improve system reliability. (L3)				
Course Content:					
Module 1	Introduction to DFT	Assignment/Quizzes	Memory Recall based Quizzes		10 Sessions
Topics: Testing importance in VLSI, VLSI Development process, electronic system manufacturing process, system level operation, Challenges, levels of abstraction, review of VLSI test technology.					
Module 2	Testability Analysis	Assignment	Simulation and analysis task		10 Sessions
Topics: Introduction, SCOAP testability analysis (combinational and sequential controllability and observability calculation), Design for testability approaches, Scan cell designs, Scan architectures, Scan design rules, Scan design flow.					
Module 3	Test Generation	Assignment/Quizzes	Design Analysis		10 Sessions
Topics: Fault models, Fault classes, ATPG algorithms for combinational circuits (path sensitization, Boolean difference, Kohavi algorithm, D-Algorithm and PODEM), Sequential ATPG.					
Module 4	Logic Built in Self-Test (BIST)	Assignment/Project	Data Analysis		10 Sessions

Introduction, BIST Design rules, test pattern generation, output response analysis, Logic BIST architectures
Targeted Application & Tools that can be used: Application Area – Hardware design Engineer, DFT engineer, VLSI design Engineer. Professionally Used Software: Cadence-Modus, Tessent
Textbook(s): 1. Laung-Terng Wang, Cheng-Wen Wu, and Xiaoqing Wen, "VLSI Test Principles and Architectures" The Morgan Kaufmann, 2013 2. N N Biswas, " Logic design theory", **Prentice Hall**
Reference Book(s): 4. Z.Navabi, "Digital System Test and Testable Design", Springer, 2011. 5. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, System-on-Chip Test Architectures: Nanometer Design for Testability, Morgan Kaufmann, First Edition, 2010. 6. 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 relevant to "EMPLOYABILITY SKILLS": Chip Fabrication Process, Compression Techniques, BIST Design Rules, Test Pattern Generation -for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms Akshaya M Ganorkar

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

Embedded Systems Basket

Course Code: ECE3467	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					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Describe the core principles of embedded software development process, encompassing safety, security and quality. (L2) CO2: Demonstrate the use of Context Diagrams and Finite State Machines (FSMs) to represent the structure and logic of embedded systems. (L3) CO3: Apply C programming principles for ARM microcontrollers utilizing control flow, pointers, and data structures. (L3) CO4: Apply debugging tools of single stepping and breakpoints to verify C programs utilizing variables, pointers, and complex data structures. (L3)					

	CO5: Examine embedded memory organization disinguishing stack, heap, and code segments and integrate tested memory manipulation routines. (L3) CO6: Implement embedded Linux configurations by compiling custom kernels, writing system scripts, and integrating Device drivers.(L3)			
Course Content:				
Module 1	Introduction to Embedded Systems Software Development	Quiz	Memory Recall based Quizzes	7 session
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),.				
Module 2	C-Programming for Embedded Systems	Assignment / Quiz	Programming	8 session
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.				
Module 3	Memory Management and Device Driver Concepts	Assignment	Analysis and Verification	17 session
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.				
Project Work/Assignment:				
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 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):

1. Joseph Yiu, "*The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors*," 3rd Edition, Newnes.

Reference(s):

Reference Book(s):

1. Michael Barr and Anthony Massa, "*Programming Embedded Systems with C and GNU Development Tools*," O'Reilly.
2. Haring D.D. et al., "Embedded Software Development With C," Springer.
3. Jane W S Liu, "Real – Time Systems", Prentice Hall, 2000.
4. Class Notes (CN).

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

1. Video lectures on "Embedded System using Arm" by Prof. Dr.Indranil Sen Gupta, IIT KGP Lecture 01: Introduction to Embedded Systems - YouTube
2. 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:

1. Camposano, R., & Wilberg, J. (1996). Embedded system design. *Design Automation for Embedded Systems*, *1*(1), 5-50. Embedded system design | SpringerLink
2. 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 Development Methodologies & Intertask Communication	Assignment/Quiz		System Design Task and Analysis	10 classes

Topics:

Foreground/Background System. Yourdon Methodology, Ward and Mellor Method, Hately and Pirbhai Method, Buffering data - Time relative Buffering- Ring Buffers - Mailboxes - Queues - Critical regions - Semaphores - other Synchronization mechanisms - deadlock - priority inversion - process stack management - run time ring buffer .

List of Laboratory Tasks: Nil

Targeted Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Embedded Systems	Design a real-time system for sensor data logging	Code Composer Studio, Keil	IoT, Medical Devices
Smart Home Automation	Develop a smart lighting control system	Arduino IDE, Python	Consumer Electronics
Automotive Systems	Real-time dashboard for vehicle diagnostics	MATLAB, Simulink	Automotive
Industrial Control	Real-time monitoring for assembly lines	LabVIEW, RTOS	Manufacturing

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Rate Monotonic Scheduling Lab	Implement static priority scheduling	FreeRTOS, Python Simulators	Task prioritization, schedulability analysis
Interrupt Handling in RTOS	Simulate ISR behavior under deadline constraints	ARM Keil, STM32	Real-time response, latency evaluation

Text Book(s):

1. Stuart Bennet, “Real-Time Computer Control”, 2nd Edn. Pearson Education.
2. “Real time Systems” by I.A.Dhotre Technical publications,1st Edition.

Reference(s)

1:C.M. Krishna, Kang G. Shin, “Real -Time Systems”, McGraw -Hill International Editions.
2: Phillip. A. Laplante, “Real-Time Systems Design and Analysis”, second edition, PHI.
3: Raj Kamal, “Embedded Systems”, Tata McGraw Hill, India, third edition

Online and Web resource (s):

1. NPTEL: https://onlinecourses.nptel.ac.in/noc21_cs98/preview
2. Udemy: https://www.udemy.com/course/real-time-systems
3. https://www.notesforgeeks.in/2021/08/ec8791-embedded-and-real-time-systems-syllabus-2017-regulation.html
4. https://nielit.gov.in/chennai/sites/default/files/Chennai/ED500-Syllabus.pdf
5. https://www.rejinpaul.com/2021/06/ec8791-embedded-and-real-time-systems.html
6. https://www.cse.iitb.ac.in/~krithi/courses/684/ts-Sep-2004.pdf
7. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content:

1. Control and Communication Challenges in Networked Real-Time Systems by J. Baillieul and P. J. Antsaklis, "Control and Communication Challenges in Networked Real-Time Systems," in *Proceedings of the IEEE*, vol. 95,no.1,pp. 9-28, Jan. 2007, doi:10.1109/JPROC.2006.887290 https://ieeexplore.ieee.org/document/4118454

2. Controller Area Network (CAN) schedulability analysis: Refuted, revisited and revisedDavis, R.I., Burns, A., Bril, R.J. al. Controller Area Network (CAN) schedulability analysis: Refuted, revisited and revised. Real-timeSyst 35,239-272(2007).https://doi.org/10.1007/s11241-007-9012-7 https://link.springer.com/article/10.1007/s11241-007-9012-7

3. Weakly hard real-time systems G. Bernat, A. Burns and A. Liamosi, "Weakly hard real-time systems," in IEEE Transactions on Computers, vol. 50, no. 4, pp. 308-321, April 2001, doi: 10.1109/12.919277 https://ieeexplore.ieee.org/document/919277

4. Scheduling real-time applications in an open environmen Deng and J. W. . -S. Liu, "Scheduling real-time applications in an open environment," Proceedings Real-Time Systems Symposium, 1997, pp. 308-319, doi: 10.1109/REAL.1997.641292. https://ieeexplore.ieee.org/document/641292

5. Design and Operation of ETA, an Automated Ellipsometer P. S. Hauge and F. H. Dill, "Design and Operation of ETA, an Automated Ellipsometer," in *IBM Journal of Research and Development*, vol. 17,no.6,pp.472-489,Nov.1973,doi:10.1147/rd.176.0472. https://ieeexplore.ieee.org/document/5391322

Topics 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 Academic Council	Meeting No. 16th , Dated 23/10/2021

<table>
<tr><td>Course Code: ECE3417</td><td colspan="2">Course Title: DSP Processors
Type of Course: Discipline Elective-Signal Processing Basket</td><td>L-T-P-C</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Version No.</td><td colspan="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">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.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of DSP Processors to improve the learners' <u>Employability Skills</u> by <u>Participative Learning</u>.</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 fundamentals of digital signal processing, DFT/FFT, digital filters and numerical effects in DSP systems.
2. Illustrate the architectural features and building blocks of commercial DSP Processor.
3. Illustrate addressing modes, peripherals, interrupts and pipelining of TMS320C54xx processor.
4. Demonstrate FIR and IIR filters on DSP Processors.
5. Examine FFT algorithms on DSP Processor with proper scaling and overflow management.
6. Employ memory and I/O interfacing techniques for efficient data transfer in DSP processors.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Introduction To Digital Signal Processing</td><td>Quiz</td><td colspan="3">Memory Recall based Quizzes</td><td colspan="2">12 session</td></tr>
<tr><td colspan="8">Topics
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</td></tr>
<tr><td>Module 2</td><td>Architectures for Programmable DSP Devices and Pipelining</td><td>Assignment / Quiz</td><td colspan="3">Programming and Simulation task</td><td colspan="2">14 session</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 3</td><td>Implementations of Basic DSP Algorithms</td><td>Assignment</td><td colspan="3">Analysis and Verification</td><td colspan="2">10 session</td></tr>
<tr><td colspan="8">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</td></tr>
</table>

Module 4	Interfacing Memory And I/O Peripherals	Assignment	Analysis and Verification	9 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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Audio Signal Processing	Real-time equalizer/filtering	Code Composer Studio, MATLAB	Consumer Electronics
Biomedical Signal Processing	ECG/EEG feature extraction	MATLAB, STM32	Healthcare
Communications	FFT-based spectrum sensing	Python, C, DSP board	Telecommunications
Edge AI Systems	Voice command recognition	CMSIS-DSP, TensorFlow Lite	IoT and Smart Devices

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
FFT Optimization	Speed up FFT algorithm for DSP chip	Code Composer Studio	Assembly tuning, fixed-point accuracy
IIR/FIR Filter Realization	Implement filters in hardware	TMS320C67x	Signal filtering, hardware constraints handling

Text Book(s):

3. Avtar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004

4. .B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications‖, Tata

Reference(s):
Reference Book(s):

17. Jonatham Stein, Digital Signal Processing‖, John Wiley, 1st Edition, 2000. 2. Sen M. Kuo & WoonSergGan,

18. Digital Signal Processors Architectures, Implementation and Application‖, Pearson Practice Hall, 1st Edition, 2013

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

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

6. Lecture series on Embedded Systems by Dr.Santanu Chaudhury, Dept. of Electrical Engineering, IIT Delhi http://nptel.iitm.ac.in

2. TMS320C54XX data sheet, product information and support https://www.ti.com/

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

E-content:

6. Gustavo Ruiz, Juan A. Michell, Design and Architectures for Digital Signal Processing. 2013, https://www.intechopen.com/books/3158

7. "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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Video Imaging	Design image filters using FPGA	Verilog, Quartus Prime	Media, Surveillance
Automotive Computing	Motor control system implementation	Verilog, Xilinx	Automobile
Aerospace Applications	Sensor fusion logic design	MATLAB, FPGA Board	Aerospace
Medical Devices	Signal acquisition from sensors	NIOS II, Verilog	Healthcare

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
PWM Controller Design	Develop PWM-based embedded logic	Vivado, VHDL	PWM generation, embedded timing
AXI-based Peripheral Integration	Connect peripherals with AXI interface	Zynq Board, Vivado IP Integrator	Bus protocols, SoC design

Project work/Assignment:

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

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

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

Text Book

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

References

1. Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press,2011.
2. J. Bhasker, "A Verilog HDL Primer, Third Edition Hardcover", Star Galaxy Publishing; 3rd edition, 2005.
3. Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing; 3rd edition,1998.

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

1.NPTEL - https://onlinecourses.nptel.ac.in/noc22_cs46/preview
2.Udemy - https://www.udemy.com/course/fpga-embedded-design-verilog/
3.Coursera - https://www.coursera.org/learn/intro-fpga-design-embedded-systems
4.Online Notes -https://ieeexplore.ieee.org/document/6186912
5.Online Notes - https://ieeexplore.ieee.org/document/6472742

E-content:

1. Carlos Leopoldo Carreón-Díaz De León ;Sergio Vergara-Limón; ,” Parameter Identification of a Robot Arm Manipulator Based on a Convolutional Neural Network” , IEEE Access (Volume: 10) 2022 , https://ieeexplore.ieee.org/document/9780143

2. Swapna Chintakunta, Raghavendra Rao Kanchi, Ramanjappa Thogata, “Designing an introductory FPGA - Based embedded system laboratory” ,American Journal of Embedded Systems and Applications ,2022 https://www.researchgate.net/publication/297717116_Designing_an_Introductory_FPGA-Based_Embedded_System_Laboratory

3. Wendell F.S. Diniz Vincent Fremont, “An FPGA-based architecture for embedded systems performance acceleration applied to Optimum-Path Forest classifier” ,Microprocessor and Microsystems, 2017 , https://reader.elsevier.com/reader/sd/pii/S0141933116302290?token=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' <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> 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: ECE3420	Course Title: Introduction to Embedded Machine Learning Type of Course: General Basket Theory only		L-T-P-C	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Comprehension of concepts/logics in Machine and Deep Learning Algorithms. Basics of Embedded Systems. Basics of Python programming for Machine and Deep Learning Algorithms.						
Anti-requisites	NIL						
Course Description	This course aims at provide introduction of an emerging field embedded machine learning. This course gives best possible insight of deploying machine learning applications on embedded systems using TinyML.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Introduction to Embedded Machine Learning and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.						
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Understand the various ML model based upon the input data. (L2) CO2: Develop various ML techniques based on embedded systems. (L3) CO3: Compare difference in RISC vs CISC architectures with example. (L2) CO4: Categorize instruction set of Cortex M controllers in TinyML. (L3) CO5: Experiment DL workflow using TinyML . (L3) CO6: Examine application built for TinyML. (L3)						
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):

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

Reference Book(s):

1. Mano, M. Morris and Ciletti Michael D., "Digital Design", 5th Edition, Pearson Education, 2020.
2. 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.):

1. Harward University Course on "TinyML" https://pll.harvard.edu/course/fundamentals-tinyml?delta=0
2. NPTEL Course on "An Introduction to Artificial Intelligence" by Prof. Mausam, IIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs56/preview
3. NPTEL Course on "Deep Learning" by Prof. Sudarshan Iyengar & Prof.Mitesh M. Khapra , IIT Madras, https://onlinecourses.nptel.ac.in/noc19_cs85/preview
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content:

1. Ahmad Shawahna , Sadiq M. Sait , and Aiman El-Maleh, "FPGA-Based Accelerators of Deep Learning Networks for Learning and Classification: A Review", IEEE Access, Volume 7, 2019, pp:7823-7859. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8594633
2. Mohammed Elnawawy , Assim Sagahyroon , and Tamer Shanableh, "FPGA-Based Network Traffic Classification Using Machine Learning", IEEE Access, Volume 8, 2020, pp: 175637-175650. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9205799
3. Tarek Belabed, Maria Gracielly F. Coutinho , Marcelo A. C. Fernandes , Carlos Valderrama Sakuyama , and Chokri Souani, "User Driven FPGA-Based Design Automated Framework of Deep Neural Networks for Low-Power Low-Cost Edge Computing", IEEE Access, Volume 9, 2021, pp: 89162 – 89180. https://ieeexplore.ieee.org/document/9458248

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 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: 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, 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 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					

Targeted Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Image Processing	Object and character recognition using CNN	Vivado, Python, TensorFlow	Healthcare, Surveillance
IoT & Edge AI	Low-power model for real-time prediction	PYNQ-Z2, Vitis AI	Smart Cities, Automation
Fault Diagnosis	Predictive maintenance of circuits	ModelSim, Vivado	Automotive, Aerospace

Communication Systems	Signal classification using RNN	Python, MATLAB	Telecom, Satellite

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Implement ML classification using VHDL	Develop logic for binary classification	Vivado, ModelSim	Logic design, synthesizable coding, binary classification
Simulate Feedforward NN on FPGA	Apply DL in digital circuits	Python, VHDL	Feedforward networks, digital inference, signal mapping
Build real-time image classifier	Deploy CNN on FPGA	PYNQ Board, OpenCV	FPGA deployment, CNN inference, vision pipeline
Analyze power and delay	Optimize VHDL-based AI code	Vivado Power Analysis	Resource profiling, energy-delay optimization

Text Book(s):

5. Deisenroth, Faisal and Ong, "Mathematics for Machine Learning", Cambridge University Press, 1st Edition, 2020. Link: https://mml-book.github.io/book/mml-book.pdf
6. 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):

1. Mano, M. Morris and Ciletti Michael D., "*Digital Design*", 5th Edition, Pearson Education, 2020.
2. Oliver Theobald, "*Machine Learning For Absolute Beginners: A Plain English Introduction*", 2nd Edition, The author, 2017.
3. Andrew W. Trask, "*Grokking Deep Learning*", 1st Edition, Manning Publications, 2019.
4. 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:

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 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

<table>
<tr><td>Course Code:
ECE3423</td><td colspan="2">Course Title: Information Theory and Coding
Type of Course: Program Core Basket
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="7">1.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">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</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</td></tr>
<tr><td>Course Objective</td><td colspan="7">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.</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 concepts of dependent and independent information sources, measures of information, entropy, information rate, and the order of a source. (L2)
2. Apply Shannon, Shannon-Fano, and Huffman encoding algorithms for efficient information source coding and reduce redundancy.(L3)
3. Interpret the behavior of discrete communication channels through input, output, and joint probability distributions.(L3)
4. Illustrate the formation of codewords, including check bits, using linear block codes, cyclic codes, and convolutional codes.(L3)
5. Evaluate the effectiveness of linear block codes for error detection and correction in digital information.(L4)
6. Analyze single-error-correcting Hamming codes, including encoding and syndrome-based decoding(L4)</td></tr>
<tr><td colspan="8">Course Content</td></tr>
<tr><td>Module 1</td><td>Introduction to Information Theory</td><td>Assignment/Quiz</td><td colspan="3">Numerical/ Memory recall based</td><td colspan="2">10 Classes</td></tr>
<tr><td colspan="8">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.</td></tr>
</table>

Module 2	Information Coding	Assignment	Numerical	10 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	15 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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Network Security	Design secure encoding using source coding	MATLAB, Python	Cybersecurity, Telecom
Satellite & Space Communication	Design a source and channel coding pipeline for deep-space telemetry data	MATLAB, Python (NumPy, SciPy), GNU Radio	Aerospace, Satellite Communications
5G NR Physical Layer Coding	Implement LDPC and Polar encoding/decoding chains used in 5G systems	MATLAB 5G Toolbox, Simulink, OpenAirInterface	Telecom, Wireless Infrastructure, IoT

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Implement Huffman and Arithmetic Encoding	Compare compression efficiencies	Python, Octave	Lossless encoding, entropy utilization, compression ratio analysis
Entropy Estimation Lab	Calculate and visualize entropy and mutual information from real data	Python (Shannon library, Matplotlib), Jupyter	Information metrics computation, probabilistic modeling
Block Code Simulator Challenge	Simulate and evaluate the performance of Hamming and BCH codes	MATLAB, Python (PyComm), GUI Builder	Error detection/correction, BER analysis, simulation proficiency

Text Book(s):

1. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996. 2. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007 Reference(s): 1. Digital Communications - Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058. **2.** Information Theory and Coding-by Dr. J. S. ChitodeTechnical Publications,First edition 2021. Online Resources (e-books, notes, ppts, video lectures etc.): 1. Video lectures on" Source coding theorem" by Prof: SN Merchant, IIT Bombayhttps://nptel.ac.in/courses/117101053 2. Videos on Entropy, Mutual Information, Conditional and Joint Entropyhttps://www.digimat.in/nptel/courses/video/108102117/L02.html 3. Presidency University Library Link https://presiuniv.knimbus.com/user#/home E-content: 1. Ye Liu, Justin P. Coon" Mitigating Bit-Synchronization Errors in Huffman-Coding-Aided Index Modulation" IEEE Communications Letters (Volume: 23, Issue: 3, March 2019) https://ieeexplore.ieee.org/document/8588988/authors#authors 2. Shigeaki Kuzuoka, Shun Watanabe "An Information-Spectrum Approach to Weak Variable-Length Source Coding With Side-Information" IEEE Transactions on Information Theory (Volume: 61, Issue: 6, June 2015) **Page(s):** 3559 - 3573.https://ieeexplore.ieee.org/document/7089269 3. Distributed Source Coding Using Abelian Group Codes: A New Achievable Rate-Distortion Region,Dinesh Krithivasan;S. Sandeep Pradhan,IEEE Transactions on Information TheoryYear2011,Volume: 57, Issue: 3,Journal Article, Publisher: IEEECited by: Pages (44)https://ieeexplore.ieee.org/document/5714261 4. Aleksandar Radonjic "Integer Codes Correcting Single Errors" IEEE Communications Letters (Volume: 22, Issue: 1, January 2018,**Page(s):** 17 - 20 https://ieeexplore.ieee.org/document/8055561
Topics relevant to "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: CO1: Demonstrate the selection of an appropriate launch vehicle for a given satellite mission based on payload mass and orbit type. (L3) CO2: Analyze the performance of a satellite communication link using Kepler's laws, EIRP, and transmission losses. (L4) CO3: Demonstrate the concepts of link power budget, system noise, uplink and downlink C/N ratio, and rain attenuation for characterizing the performance of a Ku-band satellite communication link under heavy rainfall conditions in a coastal region.(L3) CO4: Examine the performance of the power supply unit, attitude control, station keeping, thermal control, TT&C, transponders, and antenna subsystem in a geostationary satellite used for emergency communication during a cyclone disaster scenario. CO5: Apply satellite access techniques for a case study of establishing reliable communication in a remote island region using INTELSAT/INSAT/VSAT networks. (L3) CO6: Illustrate the integration of GSM and GPS technologies for location tracking in mobile communication systems. (L3)			
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:

1. Dennis Roddy, Satellite Communication, 2006, 4^{th} 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

1. 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
2. Broadband LEO satellite communications: Architectures and key technologies Y Su, Y Liu, Y Zhou, J Yuan, H Cao… - … Communications, 2019
3. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8700141
4. Development and future applications of satellite communications E Lutz, H Bischl, H Ernst, F David, M Holzbock Awa
5. https://link.springer.com/chapter/10.1007/0-387-23072-6_15
6. 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

<table>
<tr><td>Course Code: ECE3425</td><td>Course Title: Wireless Communication and Networks
Type of Course: Discipline Elective, Data Transfer Technologies Basket 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="6">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="6">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.</td></tr>
<tr><td>Anti-requisites</td><td colspan="6">NIL</td></tr>
<tr><td>Course Description</td><td colspan="6">The objective of this course is building an understanding 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.</td></tr>
<tr><td>Course Objective</td><td colspan="6">This course is designed to improve the learners' <u>EMPLOYABILITY SKILLS</u> by using <u>PROBLEM SOLVING</u> techniques using open-source Design Tools.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">On successful completion of the course students shall be able to:
CO1: Explain the basic components and limitations of wireless communication systems. (L2)
CO2: Apply the concept of cellular structure and frequency reuse to reduce interference in mobile networks. (L3)
CO3: summarise channel assignment strategies and capacity enhancement techniques in cellular systems. (L3)
CO4: Demonstrate multiple access techniques for efficient wireless communication. (L3)
CO5: Use MIMO and diversity techniques to improve wireless system performance. (L3)
CO6: Compare WLAN and WPAN standards with respect to network topology and MAC protocols for wireless communication applications. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="6"></td></tr>
<tr><td>Module 1</td><td>An Introduction to Wireless Communication and Cellular Concept</td><td>Quiz</td><td colspan="2">Memory Recall based Quiz</td><td colspan="2">10 Session</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>Module 2</td><td>Capacity Enhancement and Multiple Access Techniques</td><td>Assignment</td><td colspan="2">Case Study Based</td><td colspan="2">12 Session</td></tr>
</table>

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], C_2 = [1,-1,-1,1], C_3 = [-1,1,1,1], C_4 = [-1,1,1,-1], Considering these codes, Show that whether CDMA can be applied with these codes. Determine total no. of users in this system and give reason for your answer. Comment on capacity of CDMA. Why CDMA is called as Spread Spectrum Technology?

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

Text Book(s):
T1 Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG",

Elesvier, 2010 T2 Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
Reference(s): Reference Book(s): R1 Wireless Telecom System and Networks, Mullet: Thomson Learning 2006. R2 Fundamentals of wireless communication, David Tse, Pramod Viswanath, Cambridge 2005. Online Resources (e-books, notes, ppts, video lectures etc.): **1.** https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK **2.** https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT **3.** https://nptel.ac.in/courses/112/105/112105249/ **4.** https://www.intechopen.com/chapters/66880 **5.** Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home E-content: (Presidency University E-resources) **1.** https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications **2.** https://www.intechopen.com/books/5408 **3.** https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w **4.** https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/ **5.** https://www.mdpi.com/books/pdfview/book/1088
Topics related to development of "FOUNDATION": Beyond 5G Architecture Topics related to development of "EMPLOYABILITY": Capacity enhancement techniques, LTE-A architecture, OFDM, MIMO and Cognitive radio. Topics related to development of "ENTREPRENEURSHIP": OFDM, MIMO and Cognitive radio Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": Capacity enhancement techniques, Interference and system capacity, Handoff, Trunking and grade of service.

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

Course Code: 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 and demodulation schemes and probability theory					
Anti-requisites	NIL					
Course Description	This is an advanced research-oriented course designed for undergraduate students. This course will enable students' knowledge towards detection and tracking of radar signals. The course emphasizes on working, analysis and design of Radar wireless communication system. Additionally, this course will create a foundation for future courses such as optical Communication and Free Space Wireless Communication system.					
Course Objective	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: CO1: Explain the fundamental principles of radar systems, including electromagnetic wave propagation, the radar equation, and core system components. (L2) CO2: Apply the radar range equation and power budget calculations to determine key system performance parameters for different radar configurations. (L3) CO3: Calculate the CW, pulsed, and FMCW radar waveforms and their range resolution, velocity measurement, and ambiguity function characteristics for system configurations. (L3) CO4: Determine the matched filtering, pulse compression, Doppler processing, and MTI techniques for target detection and clutter rejection. (L3) CO5: Design antenna arrays and beamforming networks for phased array radar, optimizing gain, beamwidth, and sidelobe levels. (L3) CO6: Examine the optimal radar system configurations for applications such as weather surveillance, air traffic control, and defense, by integrating propagation effects, target characteristics, and system constraints. (L4)					
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.				

<table>
<tr><td>Module 2</td><td>The Radar Equation</td><td>Assignment / Quiz</td><td>Comprehension based Quizzes and assignments</td><td>9 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>MTI and Pulse Doppler Radar</td><td>Assignment</td><td>Comprehension based Quizzes and assignments; simulation with MATLAB</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Tracking Radar</td><td>Assignment</td><td>Project implementations in software, batch wise presentations</td><td>10 Sessions</td></tr>
<tr><td colspan="5">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)</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:

Targeted Applications: Data analytics, Automatic machine translation, object detection etc.

Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox</td></tr>
<tr><td colspan="5">Project Work/Assignment:</td></tr>
<tr><td colspan="5">1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format. Presidency University Library Link :https://puniversity.informaticsglobal.com/login

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

3. Project Assignment:- Implementation of various concepts in from Radar Engineering using Python/ MATLAB</td></tr>
<tr><td colspan="5">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.,</td></tr>
<tr><td colspan="5">Reference Book(s):</td></tr>
</table>

1. Nathanson, F E, “Radar Design Principles” Scitech Publishing.

2. Hovanessian, S.A., "Radar System Design And Analysis", Artech House

3. D.K. Barton, Modern Radar Systems Analysis, Artech House, 1988.

4. B, Edde, Radar: Principles, Technology, Applications, Prentice Hall, 1993

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

- NPTEL - https://nptel.ac.in/courses/108/105/108105154/
- COURSERA - https://www.coursera.org/specializations/optical-engineering.
- https://doi.org/10.1175/BAMS-88-11-1753.
- https://doi.org/10.1175/1520-0426(1997)014<1502:DADOAP>2.0.CO.
- Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E contents :

1. Zhang, G. F., R. J. Doviak, D. S. Zrnić, R. Palmer, L. Lei, and Y. Al-Rashid, 2011; Polarimetric phased-array radar for weather measurement: A planar or cylindrical configuration. J. Atmos. Oceanic Technol. https://www.semanticscholar.org/paper/Polarimetric-Phased-Array-Radar-for-Weather-A-or-Zhang-Doviak/537ca7fc87fd73f07da2f7044f1020d795eef77d
2. Wurman, J., Y. Richardson, C. Alexander, S. Weygandt, and P. F. Zhang, 2007; Dual-Doppler analysis of winds and vorticity budget terms near a tornado. Mon. Wea. Rev.https://www.semanticscholar.org/paper/Dual-Doppler-Analysis-of-Winds-and-Vorticity-Budget-Wurman-Richardson/2257f06925d8c069b27726e800307340e1313b93
3. Zhang, Yiming; Zhang, Shuai; Pedersen, Gert Frølund, 2020;A Simple and Wideband Decoupling Method for Antenna Array Applications. https://vbn.aau.dk/ws/files/320484972/manuscript.pdf
4. Said Mikki, dept. of ECECS, University of New Haven, West Haven, CT, USA,2018;Quantum Antenna Theory for Secure 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 of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

<table>
<tr><td>Course Code:
ECE3427</td><td colspan="2">Course Title: RF Engineering

Type of Course: Discipline Elective
Data Transfer technology Basket & 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="7">2.0</td></tr>
<tr><td>Course Pre-requisites</td><td colspan="7">To succeed in this course the student should be comfortable with basic concepts of Analog and Digital Communication courses. The basic analog and digital modulation techniques needed to translate signal from original frequency to a specified RF frequency. Multiple Access techniques are used to extend the RF communication for accommodating multiple users.</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">NIL</td></tr>
<tr><td>Course Description</td><td colspan="7">The course is designed for undergraduate students to introducer components and architecture with applications. This course will enable the students to classify different active and passive components with design and noise considerations. This will also enable the students to seek employment opportunities, research and development activities InDesign of RF control circuit and various system architectures.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to familiarize the learners with the concepts of RF Engineering and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course the students shall be able to:
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.</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>RF system-Basic architecture</td><td>Assignment</td><td></td><td colspan="2">Programming and simulation Task</td><td colspan="2">9 Sessions</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td>Module 2</td><td>Active RF components</td><td>Assignment</td><td></td><td colspan="2">Programming and Simulation Task</td><td colspan="2">10 Sessions</td></tr>
<tr><td colspan="8">Topics:
RF diodes, Bipolar junction transistors, RF Field Effect transistor, Metal Oxide Semiconductor Transistors, High Electron Mobility Transistors, Semiconductor Technology Trends</td></tr>
<tr><td>Module 3</td><td>RF Transistor amplifier and Mixer Design</td><td>Project Assignment</td><td></td><td colspan="2">Programming Task</td><td colspan="2">9 Sessions</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>Module 4</td><td>TRANSCEIVER ARCHITECTURES</td><td>Assignment</td><td></td><td colspan="2">Data collection and analysis</td><td colspan="2">10 Sessions</td></tr>
</table>

Receiver Architectures: Basic Heterodyne Receivers, Modern Heterodyne Receivers, Direct-Conversion Receivers, Transmitter Architectures: Direct-ConversionTransmitter, Modern Direct-Conversion Transmitters, Heterodyne Transmitters, OOK Transceivers

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
5G Communication	Design an RF front-end for mmWave bands	MATLAB, Simulink, ADS	Telecom, Semiconductor
IoT Systems	Low-power RF interface for home automation	GNU Radio, USRP	Home Automation, Smart Cities
Radar Systems	Design and simulate radar transceiver	MATLAB, LTSpice	Defense, Automotive
Satellite Communication	Compare satellite-based navigation RF systems	MATLAB, Simulink	Aerospace, Navigation

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Design a microstrip patch antenna	Learn high-frequency antenna design concepts	HFSS, ADS	Antenna tuning, radiation pattern analysis
Simulate RF filters for communication circuits	Understand filter behavior at RF frequencies	LTspice, MATLAB	Filter design, frequency response simulation

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: **1.** Ajinkya C Bapat1, Sonali U Nimbhorkar, Department of Computer Science and Engineering, G.H. Raisoni College of Engineering, Nagpur, RFID Based Object Tracking System Using Collaborative Security Protocol, DOI 10.4010/2016.943 ISSN 2321 3361 © 2016 IJESC,Researcharticle,Volume 6,Issue no.4 https://ieeexplore.ieee.org/abstract/document/8465897 **2.** Jasmine JoseDepartment of Electronics and Telecommunication Engineering, Don Bosco Institute of Technology, Mumbai, India, Sherin George; Lydia Bosco; Juliet Bhandari; Freda Fernandes; Ashwini Kotrashetti, A review of RF energy harvesting systems in India,International Conference on Technologies for Sustainable Development (ICTSD),2015 https://ieeexplore.ieee.org/document/7095838 **3.** John Walker; Daniel Myer; Frederick Raab; Chris Trask,Classic Works in RF Engineering: Combiners, Couplers, Transformers, and Magnetic Materials, Artech https://ieeexplore.ieee.org/document/9100964
	Topics relevant to "EMPLOYABILITY": Transceiver Architectures for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by		Mrs AKSHATHA K
Recommended by the Board of Studies on		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: CO1: Explain the architecture of IOT and WSN systems (L2) CO2: Classify various middleware protocols for building IOT and WSN applications. (L3) CO3: Illustrate real time applications of IOT and WSN to make smart world. (L3) CO4: Demonstrate competence in programming for IoT Applications. (L3) CO5: Analyze and classify the range of peer-to-peer communication protocols that facilitate the development of IoT and WSN applications. (L3) CO6: Examine synchronous deployment scenarios of IoT and WSN frameworks that facilitate the emergence of intelligent global systems. (L4)		
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 T_c is the control packet transmission propagation delay, T_w is the optimal maximum back-off time, β is the percentage of ready nodes, & R is the transmission range of each node.

Assignment 3: Assuming that all routers and hosts are working properly and that all software in both is free of all errors, is there any chance, however small, that a packet will be delivered to the wrong destination?

Assignment 4: Calculate the probability of data packet collision in the MACA protocol. Assume that T_c is the control packet transmission propagation delay, T_w is the optimal maximum back-off time, β is the percentage of ready nodes, & R is the transmission range of each node.

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

Text Book(s):

1. C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education India; 1st edition 2006, PHI.

Reference(s):

1. Roy Blake, "Wireless Communication Technology", First Edition CENGAGE, 2012
2. Jagannathan Sarangapani, "Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control" Second Edition CRC Press.
3. Ozan K. Tonguz and Gianguigi Ferrari: Ad-hoc Wireless Networks, John Wiley, 2007.
4. Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du: Ad-hoc Wireless Networking, Kluwer Academic Publishers, 2004.
5. C.K. Toh: Ad-hoc Mobile Wireless Networks- Protocols and Systems, Pearson Education, 2002

Online and Web resource (s):

1. Archive.cone.informatik.uni-freiburg.de/.../lecture/.../MANET-01.ppt
2. www.rimtengg.com/coit2007/proceedings/pdfs/122.pdf
3. people.cs.vt.edu/~irchen/6204/.../lecture4-mobile-ad-hoc-networks
4. https://nptel.ac.in/courses/106/105/106105160/
5. https://www.coursera.org/lecture/internet-of-things-history/sensor-networks-n-to-1-iOmzK
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content:

1. Wireless Sensor Network as a Mesh: Vision and Challenges by Zhanserik Nurlan, Tamara Zhukabayeva, Mohamed Othman, Aigul Adamova, And Nurkhat Zhakiyev, Digital Object Identifier 10.1109/ACCESS.2021.3137341.
2. Using Overhearing and Rateless Coding in Disseminating Various Messages in Vehicular AdHoc Networks by Mostafa Nozari, Faramarz Hendessi, Nadia H. Khiadani, And Maryam Ataei Kachooei, Digital Object Identifier 10.1109/ACCESS.2021.3110945.
3. Reliability-Aware Multi-Objective Optimization-Based Routing Protocol for VANETs Using Enhanced Gaussian Mutation Harmony Searching by Sami Abduljabbar Rashid1, Mohammed Alhartomi, Lukman Audah and Mustafa Maad Hamdi, Digital Object Identifier 10.1109/ACCESS.2022.3155632

4. Adaptive Routing Design for Flying Ad Hoc Networks Min Zhang, Chao Dong, Peng Yang, Ting Tao, Qihui Wu and Tony Q. S. Quek, IEEE Communications Letters, Vol. 26, NO. 6, June 2022 Https://Ieeexplore.Ieee.Org/Document/9716929.
Topics related to development of "FOUNDATION": MAC Protocols, Energy Management in Ad-hoc Wireless Networks Topics related to development of "EMPLOYABILITY": Security in ad hoc wireless networks, network security requirements, issues and challenges in security provisioning, network security attacks Topics related to development of "ENTREPRENEURSHIP": Battery Management Schemes, Transmission Management Schemes, System Power Management Schemes Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": MAC Protocols that use Directional Antennas, LAN's, Wi-Fi, Wi-Max.

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

Course Code: ECE3429	Course Title: Optical Communication Type of Course:: Discipline Elective- Data Transfer Technologies Basket	L- T-P- C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic concepts of electronic devices, digital modulation and demodulation schemes, analog modulation and demodulation schemes, probability theory.					
Anti-requisites	NIL					
Course Description	The purpose of this course is to enable the students to learn the basic principle of optical fiber communication and also understand the transmission characteristics and losses in a wireless communication system. The course will act as a harbinger for exponentially growing modern communication systems. The course emphasizes on working, analysis and design of wireless communication system. Additionally, this course will create a foundation for future courses such as Radar Communication and Free Space Communication etc.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Optical Communication and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1 Explain basic concepts of OWC systems including wireless access schemes. (L2) CO2 Explain the safety regulations and environmental factors affecting the deployment of OWC systems. (L2) CO3 Analyze the working principles and performance parameters of optical sources (LEDs and LASERs) and detectors (PIN and APD). (L4) CO4 Apply suitable analog and digital modulation techniques to optical wireless communication systems. (L3) CO5 Analyze the application areas such as LiFi, underwater communication, and vehicle-to-vehicle (V2V) systems. (L4)					

	CO6 Employ complete optical wireless communication systems by integrating components, modulation schemes, and performance optimization techniques (L3)			
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	Optical Sources & Detectors	Assignment	Design oriented	13 Sessions

Optical Sources :

LED & LASERS: Internal & External Quantum Efficiency, Power Efficiency, Luminous Efficiency, Modulation Bandwidth

Optical Detectirs :

PIN & APD Photo Detectors, Direct & Coherent Detection Techniques Detection Noise

Module 3	Modulation Techniques	Assignment	Design Analysis	12 Sessions

Topics

Introduction, Analogue Intensity Modulation, Digital Baseband Modulation Technique Pulse Position Modulation, On–Off Keying, Multi carrier modulation (MCM) techniques

Module 4	Use Cases	Assignment	Application based analysis	10 Sessions

Module 4: Use Cases

Visible Light Communication: System Design, SNR Analysis, MIMO VLC, WiFi/LiFi Co-existence, Under Water Communication, V2V Communication.

Targeted Application & Tools that can be used:

Tools: MATLAB

Project work/Assignment:

Project/Assignment:.

1. Performance Analysis of OOK, PPM and OFDM Modulation Techniques for VLC
2. Comparative Performance Analysis of PIN and APD Photodetectors.
3. Compare the Bit Error Rate for various weather conditions.

Text Book

T1: Ghassemlooy Z, Popoola, Rajbhandari. “Optical Wireless Communication System and Channel Modelling With MATLAB”, CRC Press (Taylor & Francis Group) 2013

References

R1. Ramirez R, M Sevia. “Optical Wireless Communications IR for Wireless Connectivity)”, CRC Press (Taylor & Francis Group) 2008

R2 H Steve N. Wireless Optical Communication System. Springer, 2005.

Online Resources & E-content(e-books, notes, ppts, video lectures etc.): NPTEL - https://onlinecourses.nptel.ac.in/noc23_ee61/preview ResearchPapers : 1. D. Karunatilaka, F. Zafar, V. Kalavally, and R. Parthiban. *LED Based Indoor Visible Light Communications*: State of the Art. In: IEEE Communications Surveys & Tutorials, vol. 17, no.3,pp.1649–1678,2015.DOI:10.1109/COMST.2015.2471304. 2. H. Elgala, R. Mesleh, and H. Haas. Indoor Optical Wireless Communication: Potential and State-of-the-Art. IEEE Communications Magazine, vol. 49, no. 9, pp. 56–62, Sept. 2011. DOI: 10.1109/MCOM.2011.6011734
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. Nishant Sharan
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.					

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

CO1: Explain the principles, components, and sources of error in measurement systems used for biomedical sensing applications. (L2)
CO2: Apply the working principles of resistive sensors such as potentiometers, strain gauges, RTDs, thermistors, LDRs, hygrometers, and gas sensors in wearable monitoring applications. (L3)
CO3: Discuss the concepts of integrated and smart sensors, IEEE 1451 standards, and Transducer Electronic Datasheets (TEDs).(L2)
CO4: Illustrate the working principles and applications of smart sensors, MEMS sensors, flexible sensors, and structural health monitoring sensors. (L2)
CO5: Explain the role, attributes, and classifications of wearable devices used in healthcare and assistive technologies. (L2)
CO6: Apply wearable sensor concepts for physiological monitoring, body movement analysis, food intake characterization, and sensing inside and outside the human body.(L3)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Resistive and Reactive Sensors</td><td>Assignment</td><td>Case study based</td><td>08 Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Smart Sensors and Applications</td><td>Project</td><td>Small hardware based</td><td>09 Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>Scope of Wearable Devices</td><td>Assignment</td><td>Small hardware based</td><td>08 Classes</td></tr>
<tr><td colspan="5">Topics:
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Wearable and non-invasive 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.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Targeted Applications: :
1. Fabrication of interdigitated (IDE) electrodes.
2. Piezoresistive sensors for cuffless blood pressure measurement.
3. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.
4. Smart textile for neurological rehabilitation system (NRS)
5. Epidermal electronics system (EES)
6. 3D imaging and motion capture
7. safety and security, navigation, Enhancing sports media, Automatic digital diary
8. AI for respiratory diagnostics and clinical trials.

Professionally Used Software: python/C,C++, Virtual testing through simulation in ANSYS software.</td></tr>
<tr><td colspan="5">Project work/Assignment/Quiz:</td></tr>
</table>

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

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

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

Text Book(s):

1 "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, Academic Press/Elsevier, ISBN 978-0124186620, Edward Sazonov, Michael R. Neuman (editors), 2nd edition.

Reference(s):

Reference Book(s):

1 "Wearable Electronics Sensors-For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015

2 M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018.

3 "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018

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

1. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK
2. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT
3. https://nptel.ac.in/courses/112/107/112107289/
4. https://nptel.ac.in/courses/112/105/112105249/
5. https://www.intechopen.com/chapters/66880
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-Content: (Presidency University E-resources)

1. https://presiuniv.knimbus.com/openFullText.html?DP=http://www.intechopen.com/books/advanced-trends-in-wireless-communications
2. https://www.intechopen.com/books/5408
3. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w
4. https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/
5. https://www.mdpi.com/books/pdfview/book/1088

Topics related to development of "EMPLOYABILITY": Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, 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: ECE3432	**Course Title:** Flexible Electronics And Sensors **Type of Course:** Discipline Elective- AI and Wearable Technologies Basket	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Measuring Instruments and Sensors.					
Anti-requisites	**NIL**					
Course Description	The purpose of this course is to provide an overview of flexible electronics technology and issues related material processing for thin film electronics. This course exposes the students for the materials selection and patterning methods for thin film electronics development. This course describes the process involved in transferring the flexible electronics from foils to textiles and also the challenges, opportunities and the future of wearable devices. It exposes the students to the design, challenges of wearable sensors employed for sensing the physical and biological parameters. A review on the process involved in the conversion of conducting and semiconducting fibers to smart textiles.					
CourseObjective	**The objective of the course is to familiarize the learners with the concepts of Flexible Electronics and Sensors and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING.**					
Course Outcomes	**On successful completion of this course the students shall be able to:** CO1: Explain the evolution of flexible electronics, the materials and technologies used in flexible electronic systems. (L2) CO2: Describe the principles of low-temperature electronic device fabrication and the fundamentals of wearable technologies, including wearable haptic and tactile display systems. (L2) CO3: Describe the material considerations and functional characteristics of semiconductors, dielectrics, and conductors employed in flexible electronics. (L2) CO4: Demonstrate the use of jet-printing and related print-processing approaches for patterning and fabricating flexible electronic devices. (L3) CO5: Illustrate the principles of printing, lithography, multilayer patterning, and surface engineering techniques used in flexible electronics fabrication. (L2) CO6: Demonstrate the selection of suitable fabrication and patterning techniques for the development of flexible electronic devices such as displays, sensors, MEMS, lab-on-a-chip systems, and solar panels.(L3)					
Course Content:						

Module 1	**Overview of flexible electronics technology**	Case study / quiz	flexible electronics technology	**10session**
History of flexible electronics - Materials for flexible electronics: degrees of flexiblility, substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to Roll processing - Additive printing.				
Module 2	**Amorphous and nano-crystalline silicon**	Case study /	World of wearables	**10session**

<table>
<tr><td></td><td>materials and Thin film transistors and Wearable haptics</td><td>quiz</td><td></td><td></td></tr>
<tr><td colspan="5">Topics:
Fundamental issues for low temperature processing - low temperature amorphous and nanocrystalline silicon - characteristics of low temperature dielectric thin film deposition - low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability. World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunities - Future of wearables - Need for wearable haptic devices - Categories of wearable haptic and tactile display.</td></tr>
<tr><td>Module 3</td><td>Materials and Novel patterning methods for flexible electronics</td><td>Case study / quiz</td><td>Print processing</td><td>12 session</td></tr>
<tr><td colspan="5">Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.</td></tr>
<tr><td>Module 4</td><td>Flexible electronics from foils to textiles & Wearable Bio, Chemical and Inertial sensors</td><td>Case study / quiz</td><td>Jet Printing</td><td>12session</td></tr>
<tr><td colspan="5">Ink-jet printing, gravure, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning, design rule considerations. Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip, and flexible solar panels</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Project Assignment:
1. Article review: At the end of course an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on their understanding about the assigned article in appropriate format.<u>Presidency University Library Link</u> .
3. Presentation: There will be a group presentation, where the students will be given a topic. They will have to explain/demonstrate the working and discuss the applications for the same.
4. Project Assignment: -Printed electronics has the potential to revolutionize many industries. Some of the most interesting possibilities are in the areas of textiles and clothing. With electronics printed onto a substrate that is then applied to fabrics, we can add sensors, displays or other elements to existing clothing designs, or create entirely new items that take advantage of added features. Do survey on wearable sensors for monitoring patient health care system.</td></tr>
</table>

Text Book(s):

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, “Sensor Technologies: Healthcare, Wellness and Environmental Applications”, 201, 1st Edition, Apress Media LLC, New York.

2 William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.

Reference(s):

1. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge.
2. Kate Hartman, “Make: Wearable Electronics: Design, prototype, and wear your own interactive garments”, 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. Yugang Sun, John A. Rogers, “Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies)”, 2011, 1st Edition, William Andrew, New York.

Online and Web resource (s): 1. https://nptel.ac.in/courses/108/108/108108147/ 2. https://www.coursera.org/learn/freeform-electronics 3. https://presiuniv.knimbus.com/user#/home **E-Content:** 1. Mario Caironi,Yong-Young Noh"Latest Advances in Substrates for Flexible Electronicsin Journal of the Society for Information Display, First published: 16 January 2015, https://doi.org/10.1002/9783527679973.ch10. 2. Panpan Wang,Mengmeng Hu,Hua Wang,Zhe Chen,Yuping Feng,Jiaqi Wang,Wei Ling,Yan Huanga "The Evolution of Flexible Electronics: From Nature, Beyond Nature, and To Nature"inFirst Advanced Sciences published: 28 August 2020 https://doi.org/10.1002/advs.202001116https://onlinelibrary.wiley.com/doi/full/10.1002/advs.202001116 . 3. Marc Aliqué,Claudia Delgado Simão,Gonzalo Murillo,Ana Moya"Fully-Printed Piezoelectric Devices for Flexible Electronics Applications" in Advanced Materials Technogolies First published: 25 January 2021. https://doi.org/10.1002/admt.202001020 https://onlinelibrary.wiley.com/doi/abs/10.1002/admt.202001020,
Topics relevant to "EMPLOYABILITY SKILLS": World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunitiesfordeveloping **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Srilakshmi K H Dr. K Bhanu Rekha
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: 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 the need for development of wearable devices and it simplications on various sectors. It will also comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. The course will enable the students to become acquainted with various wearable locomotive sensors as assistive devices for tracking and navigation. This course also helps in carrying out research and development activities or employment opportunities in the area of wearable devices.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Wearable Devices and its Applications and attain EMPLOYABILITY SKILLS through PARTICPATIVE LEARNING					

<table>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of the course students shall be able to:
CO1: Explain the evolution, attributes, and classification of wearable devices including types of wearable sensors (invasive and non-invasive) and their applications. (L2)
CO2: Classify wearable inertial sensors including accelerometers, gyroscopic sensors, and magnetic sensors based on their modality of measurement.(L2)
CO3: Illustrate the applications of wearable inertial sensors in fall risk assessment, fall detection and gait analysis. (L3)
CO4: Analyze the role of wearable cameras in safety and security, navigation, sports and smart-watch applications. (L4)
CO5: Explain the principles of MEMS microphones and bio-acoustics, and their integration with AI for respiratory diagnostics and clinical trials.(L2)
CO6: Analyze wearable assistive devices and their applications including devices for vision, hearing, touch sensation, and various body-worn assistive technologies.(L4)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Wearable Devices</td><td>Quiz</td><td>Memory Recall based Quiz</td><td>09 Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Wearable Inertial Sensors</td><td>Assignment</td><td>Case study based</td><td>08Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>Wearable Cameras and Microphones for Navigation</td><td>Project</td><td>Small hardware based</td><td>14Classes</td></tr>
<tr><td colspan="5">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, Bio acoustics, 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, fore arm and-feet, vests and belts, head-mounted devices.</td></tr>
<tr><td>Module 4</td><td>Other Applications</td><td>Assignment</td><td>Small hardware based</td><td>08 Classes</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used:
Targeted Applications:
1. Fabricationofinterdigitated (IDE)electrodes.
2. Piezoresistive sensors for cuffless blood pressure measurement.
3. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring.</td></tr>
</table>

4. Smarttextileforneurologicalrehabilitationsystem (NRS)
5. Epidermalelectronicssystem (EES)
6. 3Dimagingandmotioncapture
7. safety and security, navigation, Enhancing sportsmedia, Automatic digital diary
8. AIforrespiratorydiagnosticsand clinicaltrials.

Professionally Used Software: ANSYS software, python/C, C++

Project work/Assignment/Quiz:

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

2. Book Review/ Article review: A chapter of abook or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page.
3. Presentation: There will be a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.

Text Book(s):

1 "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018, 1st edition
2 "WearableSensors-Fundamentals, ImplementationandApplications", byEdwardSazonovand Michael R. Neuman, ElsevierInc., 2014, 2nd edition

Reference(s):

Reference Book(s):

1"Wearable Electronics Sensors-For Safe and Healthy Living", SubhasChandra Mukhopadhyay, Springer2015

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

3"Environmental, ChemicalandMedicalSensors", byShantanuBhattacharya, AKAgarwal, NripenChanda, AshokPandeyandAshisKumarSen, SpringerNatureSingaporePteLtd. 2018

4. MardonovaandY.Choi,"ReviewofWearableDeviceTechnologyandIts Applicationstothe MiningIndustry,"Energies, vol.11, p. 547,2018.

Online Lectures:

1. https://www.coursera.org/lecture/healthcare-it/module-3-wearables-w1ayK
2. https://www.coursera.org/lecture/introduction-to-digital-health/mobile-applications-and-wearable-technologies-FnyjT
3. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

Website:

1. https://nptel.ac.in/courses/112/107/112107289/
2. https://nptel.ac.in/courses/112/105/112105249/
3. https://www.intechopen.com/chapters/66880

E-Content: (Presidency University E-resources)

1. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-022-02110-w
2. https://www.ksp.kit.edu/site/books/m/10.5445/KSP/1000051989/
3. https://www.mdpi.com/books/pdfview/book/1088

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 sessions	
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 sessions	
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):

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

Reference(s):

Reference Book(s):

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

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

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

E-content:

1. Jin-Ho Yoo, Hyun-Tae Jeong, Yeon Cho, "A Study On The Wearable Embedded System Platform",The Journal of Korean Institute of Communications and Information Sciences, 2005 https://www.researchgate.net/publication/264114985_A_Study_On_The_Wearable_Embedded_System_Platform

	2. LechJóźwiak, “Advanced mobile and wearable systems” ,Microprocessors and Microsystems, Volume 50, May 2017, Pages 202-221 https://www.sciencedirect.com/science/article/abs/pii/S0141933117300741#! 3. AMOL S. PATIL,UMESH J. TUPE, “ Recent Trends in Platforms of Embedded Systems",International Journal of Creative Research Thoughts, VOL. 8, issue.11 https://www.ijcrt.org/papers/IJCRT2011003.pdf 4. D.T sai, W.Morley, G.J.Suaninga, N.H.Lovell, A wearable real-time image processor for a vision prosthesisComputer Methods and Programs in Biomedicine, Volume 95, Issue 3, September 2009, Pages 258-269 https://www.sciencedirect.com/science/article/abs/pii/S0169260709000923
	Topics relevant to ”EMPLOYABILITY”: Interfacing with ARM, programming ARM with assembly and C for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	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:

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

Assignment-1: Study of Wearable EEG electrodes: Design and measurement of electrical activity of brain.

Assignment-2. Study of Wearable EMG electrodes: Design and measurement of electrical activity of muscle cells.

Assignment-3: Study of Wearable motion sensors using textile-based MEMS accelerometer

Text Books:

1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.

Reference Books:

1. “Wearable Electronics Sensors - For Safe and Healthy Living”, Subhas Chandra Mukhopadhyay, Springer 2015.
2. “Environmental, Chemical and Medical Sensors”, by Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018
3. "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, by M. Mardonova and Y. Choi, vol. 11, p. 547, 2018.

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

1. Ambient assisted living and enhanced living environments: principles, technologies and control Ciprian Dobre, First Edition<https://www.elsevier.com/books/ambient-assisted-living-and-enhanced-living-environments/dobre/978-0-12-805195-5 >
2. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088>
3. Case studies on Wearable technology<https://www.hticiitm.org/wearables>

E-content:

1. Patel, S., Park, H., Bonato, "A review of wearable sensors and systems with application in rehabilitation″ J NeuroEngineeringRehabil 9, 21 (2012). https://doi.org/10.1186/1743-0003-9-21.
2. Muhammad Mahtab Alam,″ Wearable Wireless Sensor Networks: Applications, Standards and Research Trends″Jan 2015 http://dx.doi.org/10.1201/b20085-6.
3. Bujari, A. &Gaggi, Ombretta &Quadrio, Giacomo. (2018). Smart Wearable Sensors: Analysis of a Real Case Study. 10.1109/PIMRC.2018.8580729 ." *Ieee Micro*, vol. 16, no. 6 (1996),pp10-20.
4. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

Topics relevant to “EMPLOYABILITY” : Wearable Devices for Healthcare, Wearable Cameras and Microphones for Navigation for developing EMPLOYBILITY SKILLS through PARTICIPATIVE LEARNING Techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Dr.M.S Divya Rani Dr. Sumantra Chaudhuri
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

Course Code: 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					

<table>
<tr><td>Course Description</td><td colspan="4">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.</td></tr>
<tr><td>Course Objective</td><td colspan="4">This course is designed to improve the learners' EMPLOYABILITY SKILLS by using EXPERIENTIAL LEARNING techniques using AI & IOT.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">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.</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Introduction to Networking Basics and Location in ubiquitous computing:</td><td>Quiz</td><td>Memory Recall based Quizzes</td><td>10Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 2</td><td>Context-aware computing</td><td>Assignment/Quiz</td><td>Theoretical Understanding</td><td>11 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 3</td><td>Wearable and Mobile affective computing</td><td>Assignment/Quiz</td><td>Theoretical Understanding</td><td>7 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Module 4</td><td>Introduction to IoT and data analytics</td><td>Assignment</td><td>Theoretical Understanding</td><td>9 Sessions</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Application & Tools that can be used: Application Area is in the field of assistive robotics, Automatic machine translation, object detection etc.</td></tr>
</table>

Professionally Used Software: python/C,C++,Jupyter Notebook on cloud/ MATLAB.	
Project work/Assignment:	
1.Case Studies: At the conclusion of each module, we will have a 'case-based' discussion session for approximately half the class period. Cases will be from lecture / journal article content by considering a 'real-world' scenario where the course concepts can be applied. We will post the case one week in advance. For each case, each student from each group formed will write a 1-2-page executive summary outlining their understanding, including relevant analyses, schematics, and graphs. Guidelines on report format will be provided with the first case.Presidency University Library Link. 2.Book/Article review: At the end of each module, a book or an article will be given to each student. They need to visit the library and write a report on their understanding about the assigned article for 1 page. 3.Presentation: There will a group presentation on latest trends and advancements in Wearable robots.	
Text Book(s): 1. Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010 First Edition 2. Papers from the ACM and IEEE digital libraries.	
Reference(s): 1. Jacob Rosan, "Wearable Robots", 2019, First Edition, Elsevier. 2. https://nptel.ac.in/courses/106/103/106103220/ Online Resources (e-books, notes, ppts, video lectures etc.): 1. Lecture Series on Embedded Systems by Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT Delhi (315) Lecture - 37 Pervasive & Ubiquitous Computing - YouTube 2. Thad Starner reviews the greatest hits of wearable computing and describes an unusual and surprising application currently being explored at Georgia Tech, where Starner is an Associate Professor in the School of Interactive Computing (315) Wearable Computing: the Next Generation of 'Borg - YouTube E-content: **1.** Context-awareness in wearable and ubiquitous computing by D Abowd, AK Dey, R Orr, J Brotherton - Virtual Reality, 1998 – Springer. **2.** An architecture concept for ubiquitous computing aware wearable computers by M Bauer, B Brugge, G Klinker, computing Systems …, 2002 - ieeexplore.ieee.org 3. Overview of the Internet of Things and Ubiquitous Computing S Mehrotra, S Sinha, SK Sharma - Blockchain Technology for …, 2021 - taylorfrancis.com	
Topics relevant to "EMPLOYABILITY SKILLS": Semantic Web Data Management, Searching in IOT, Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processingfordeveloping Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout	
Catalogue prepared by	Ms. Swetha.G
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the	Meeting No. 18th, Dated 03/08/2022

Academic Council	

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	Assignment/Quiz	Theoretical Understanding	7 Sessions

	wearable robots			

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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Assistive Robotics	Design a control system for exoskeleton knee joint	Python, C++	Healthcare, Rehabilitation
Telemanipulation	EEG-based control for remote prosthetic hand	MATLAB, OpenBCI	Telemedicine, Defense
Rehabilitation	EMG-based limb assistance using wearable device	Arduino, EMG sensors	Neurotherapy
Human Augmentation	Force estimation using sEMG data	TensorFlow, SciKit-Learn	Sports Tech, Military

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Design EMG-controlled robotic arm	Control prosthetic limb using biosignals	Arduino, MyoWare EMG sensor	Bio-signal mapping, actuation design
Simulate gait cycle in robotic exoskeleton	Model joint control strategies	MATLAB Simscape, ROS	Biomechanics, robotic kinematics

Text Book(s):
1. Pons, José L. Wearable robots: bio mechatronic exoskeletons, John Wiley & Sons, 2008

Reference(s): 1. Winter, David A. Biomechanics and motor control of human movement . John Wiley &Sons, 2009 2. Jacob Rosan, “Wearable Robots” , 2019, First EditionWearable Robots” ,, Elsevier Online Resources (e-books, notes, ppts, video lectures etc.): 1. https://nptel.ac.in/courses/112/107/112107289/ 2. https://nptel.ac.in/courses/112/105/112105249/ 3. (315) 06: Wearable Robotic Technologies - Chapter 3 - Exoskeletons (Part 2) - YouTube E-content: 1. Simulation of Stand-to-Sit Biomechanics for *Robotic* Exoskeletons and *Prostheses* with Energy Regeneration. IEEE Transactions on Medical *Robotics* **2.** Benchmarking Wearable Robots: Challenges and ... – Frontiers-https://www.frontiersin.org › frobt.2020.561774 › full by D Torricelli · 2020 **3.** Human-Centered Design of Wearable Neuroprostheses-https://ojs.aaai.org › aimagazine › article › by JL Contreras-Vidal · 2015.
Topics relevant to “EMPLOYABILITY SKILLS” : Electromyography models and parameters; Surface EMG signal feature extraction; Classification of EMG activity; Force and torque estimation for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Catalogue prepared by	Ms.Swetha.G
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th, Dated 03/08/2022

IoT & Sensor Technologies Basket

Course Code: ECE3439	Course Title: IoT Architecture and Protocols Type of Course:	L- T-P-C	3	0	0	3
Version No.	2.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The purpose of this course is to introduce the students to the Internet of Things (IoT) technologies and Industry 4.0 which is transforming the industry by integrating modern technology with the help of sensors, computational processes and communication technologies. The course inculcates critical					

<table>
<tr><td></td><td colspan="4">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="4">The objective of the course is <u>SKILL DEVELOPMENT</u> of student by using <u>PARTICIPATIVE LEARNING</u> techniques</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">On successful completion of this course the students shall be able to:

CO1: Explain the types of Internet of Things (IoT) architectures namely, standard, 2-layer, 3-layer and simplified IoT architectures. (L2)
CO2: Describe the functions of sensors and actuators. (L2)
CO3: Choose the appropriate IoT platform from Cloud based, Edge based, or Fog based architecture for a given application scenario. (L3)
CO4: Compare the cloud computing service models and cloud service providers for IoT applications. (L4)
CO5: Analyze the IPV4 and IPV6 communication protocols used in IoT applications. (L4)
CO6: Design an IoT based application using Arduino boards. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>IoT Architecture & components</td><td>Assignment/ Quiz</td><td>Memory Recall based Quizzes</td><td>12 Sessions</td></tr>
<tr><td colspan="5">Topics:
Basics of IoT, Design and Components, future of the technology, scope and Challenges, IoT enabled Areas, characteristics, Market research for the technology, Sensors and actuators, M2M IoT standard Architecture, IoT world forum (IoTWF) standardized architecture. Architecture (2 ,3 Layer) , Physical device and control layer, Connectivity layer, edge computing layer, Upper layers, IoT reference Model . simplified IoT architecture-A core of IoT functional Stack</td></tr>
<tr><td>Module 2</td><td>Data management</td><td>Assignment/ Quiz</td><td>Real time Application Project</td><td>12 Sessions</td></tr>
<tr><td colspan="5">Topics:
Selection of IoT Platform, Embedded System, data management and computing stack- Edge computing, Fog computing cloud computing, Cloud architecture, SaaS, PaaS, IaaS. Cloud service provider Google Cloud, AWS</td></tr>
<tr><td>Module 3</td><td>Communication in IoT</td><td>Assignment/ Quiz</td><td>Memory Recall based Quiz</td><td>11 Sessions</td></tr>
<tr><td colspan="5">Iot Accessing technology- IEEE 802.15.1, networking layers, physical layer and topology. IPV4 and IPV6 Addressing IoT nodes, IoT Edge, 6LOWPAN, MQTT, AMQP, COAP and MDNS, Web socket Application aware communication, Network and channel aware communication - Topologies and Hierarchy, IoT LAN and WAN connectivity RFID, BLE, LPWAN , LORA .Real time application of IoT.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks:
NIL</td></tr>
<tr><td colspan="5">Targeted Applications and Tools
<table>
<tr><th>Application Area</th><th>Hands-on Application Problem</th><th>Tools Utilised</th><th>Relevant Industries</th></tr>
<tr><td>Healthcare</td><td>Remote patient monitoring</td><td>Raspberry Pi, AWS IoT Core</td><td>Healthcare, MedTech</td></tr>
<tr><td>Agriculture</td><td>Smart irrigation system</td><td>Arduino, LoRa</td><td>AgriTech</td></tr>
<tr><td>Transport</td><td>Vehicle tracking</td><td>GPS modules, MQTT</td><td>Logistics</td></tr>
</table></td></tr>
</table>

Retail	Smart inventory management	BLE, Cloud Dashboard	E-commerce

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Build MQTT-based smart sensor network	Demonstrate lightweight IoT protocol usage	ESP32, Mosquitto	IoT stack implementation, publish-subscribe model
Implement CoAP protocol on constrained devices	Test RESTful protocol in edge environments	Contiki OS, Cooja Simulator	Low-power networking, protocol simulation

Project Work/Assignment:

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

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

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

4.Assignment: Project Assignment: Design a IOT based application for healthcare and agriculture and physically challenged peoples.

Assignment: 1] Write a brief report on Current IOT based systems available and identify their components, the Network they are using to communicate.

Assignment: 2] Design a IOT based application for
a. Health care
b. Agriculture
c. Transport Management
1 Stock Management
e. COVID-19

Text Book(s):

1. Sudip Misra, Anandarup Mukherjee, Arijit Roy "Introduction to IOT ", Cambridge University Press, January 2021

Reference(s):

Reference Book(s):

R1 Arshdeep Bagha & Vijay Madisetti, "Internet of Things a Hands-on Approach"

R2 Adrian McEwen & Hakim Cassimally "Designing the Internet of Things"

R3 IoT Fundamentals
Networking Technologies, Protocols, and Use Cases for the Internet of Things
By David Hanes, CCIE No. 3491 Gonzalo Salgueiro, CCIE No. 4541

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

1. https://nptel.ac.in/courses/117/103/117103063/

2.https://nptel.ac.in/courses/108108179 **E-Content: -** **1** Cheena Sharma and Naveen Kumar Gondhi 2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU) 23-24 Feb. 2018Communication Protocol Stack for Constrained IoT Systems. https://ieeexplore.ieee.org/document/8519904/authors#authors **2** Bertha Mazon-Olivo and Alberto Pan IEEE Latin America Transactions 1 Jan.-2022 Internet of Things: State-of-the-art, Computing Paradigms and Reference Architectures. https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=9662165 3. Isaac Odun-Ayo, M. Ananya, Frank Agono and Rowland Goddy-Worlu ,2018 18th International conference on Computational Science and Applications (ICCSA), 2-5 July 2018,Cloud Computing Architecture: A Critical Analysis.https://ieeexplore.ieee.org/document/8439638 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
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: ECE3440	**Course Title: Hardware and Software Architecture for secured IoT Systems** **Type of Course: Discipline Elective- IOT and Sensor Technologies Basket**	**L- T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basic understanding of communication protocol stacks. Interfacing of Raspberry pi. Assembly language programming and computer system architecture knowledge.					
Anti-requisites	NIL					
Course Description	The course aims at studying holistically the software and hardware architectures of IoT Systems for better understanding of deployment in the real world. As both the architectures work in conjunction with each other so the course aims at systematically exploring key anchor points between the two and how they can create a functional IoT system.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Hardware and Software Architecture for secured IoT Systems and attain SKILL DEVELOPMENT through PARTICIPATIVE LEARNING techniques.					

Course Outcomes	On successful completion of this course the students shall be able to: CO1: Recognize the Infrastructure and Networking Protocols technologies of Internet of Things (IoT) .(L2) CO2: Demonstrate the Interfacing of sensors with Arduino / Raspberry Pi.(L3) CO3: Interpret the significance of Big Data and Cloud computing in IoT .(L3) CO4: Describe the features and concepts of Clustering and Web of Things (WoT). (L3) CO5: Analyze hardware and software requirements along with various implementation platforms for IoT systems.(L4)			
Course Content:				
Module 1	**IoT Fundamentals and Reference Architecture, Software Design**	Quiz	Memory Recall based Quizzes	**10 Classes**
Topics: Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security. Control Units – Communication modules – Bluetooth – Zigbee – WIFI – GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP etc..), MQTT, Wired Communication, Power Sources				
Module 2	**Programming the microcontroller for IoT**	Assignment / Quiz	Programming and Simulation task	**10 Classes**
Topics: IOT structure - RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IOT Enabling Technologies - BigData Analytics, Cloud Computing, Embedded Systems. Working principles of sensors – IOT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication.				
Module 3	**Resource management and Web of Things**	Assignment	Simulation Tasks	**12 Classes**
Topics: Clustering, Clustering for Scalability, Clustering for routing, Clustering Protocols for IOT The Future Web of Things – Set up cloud environment –Cloud access from sensors– Data Analytics for IOT- Rest Architectures- The web of Things				
Module 4	**Hardware and Software of IoT**	Assignment	System Design Task and Analysis	**07 Classes**
Topics: IoT Physical Devices and Endpoints – Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins. IoT Physical Servers and Cloud Offerings – Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API				
Project work/Assignment:				
Project Assignment: Implementing Cloud services on Decentralized platforms. **Presentation: There will a group presentation on the programming assignment or any course related self-study topic/research related topic they had done.** **Students will be made into group and given the programming assignment at the end of each module. Students need to use IoT Development Kits like Azure for these assignments.** **Tools:**				

1. **Arduino IDE, Arduino Cloud**
2. **IoT Cloud Remote, Web Editor**

Textbook(s):

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 1 st edition, Wiley Publications, 2019.
2. Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A hands-on approach, 1st edition, University press, 2014.

Reference Books:

1. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1 st edition, NCC Group, 2014 2. DaCosta, Francis, and Byron Henderson.
2. Rethinking the Internet of Things: a scalable approach to connecting everything, 1 st edition, Springer Nature, 2013.

E-Content:

1. A Taxonomy of IoT Client Architectures **https://ieeexplore.ieee.org/document/8354417**
2. Software-Defined Edge Computing (SDEC): Principle, Open IoT System Architecture, Applications, and Challenges https://ieeexplore.ieee.org/document/8907456
3. Software Test Architectures and Advanced Support Environments for IoT https://ieeexplore.ieee.org/document/8411760
4. A Remotely Configurable Hardware/Software Architecture for a Distance IoT Lab https://ieeexplore.ieee.org/document/9556236

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

1. https://www.udemy.com/course/embedded-electronics-bootcamp-from-bit-to-deep-learning/
2. https://nptel.ac.in/courses/106105159
3. https://rfwireless-world.com/IoT/IoT-architecture.html
4. https://www.udemy.com/course/iot-solution-with-esp32-and-aws/

Topics relevant to development of "EMPLOYABILITY SKILLS": Topics relevant to "EMPLOYABILITY SKILLS": System Design and Process Control in IoT, Leading skills for IoT computing are system design, architecture privacy and security **for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout**.

Catalogue prepared by	Nipun Sharma
Recommended by the Board of Studies on	15th BOS held on28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/2022

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 desesigning 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: CO1: Describe the frameworks for IIoT applications in industries. (L2) CO2: Interpret the challenges in implementing IIoT with different computing types in industry. (L3) CO3: Classify between centralized and federated learning approaches and their respective strengths and weaknesses. (L3) CO4: Illustrate Legacy Industrial and Modern Communication Protocols and Middleware Architecture, LoRaWAN- and Augmented reality. (L3) CO5: Appraise the appropriate protocol for communication between IoT devices. (L4) CO6: Examine real world applications of edge computing. (L4)			
Course Content:				
Module 1	Introduction to IoT	Assignment	Memory Recall based Quizzes	10 session
Topics: Overview and Basic concepts of IoT, IoT architecture and components, - Sensors, Interface, Networks, Key terms – IOT Platform, Interfaces, clouds, Data Analytics, Challenges. Various Architectures of IOT, Advantages & disadvantages. Physical Design of IoT, Logical Design of IoT, IoT enabling Technologies, IoT Applications.				
Module 2	Introduction to IIOT and the technical and business Innovators of Industrial Internet	Assignment	Memory Recall	10 session
Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT, Role of edge nodes in IoT. The Technical & Business Innovators of Industrial Internet: Miniaturization, Cyber Physical Systems, Wireless Technology, IP Mobility, NFV, Cloud and Fog, Big Data & Analytics, M2M & Artificial Intelligence, Augmented Reality, 3D Printing. IIOT Reference architecture.				
Module 3	Introduction to Edge Computing and Challenges in Federating Edge Resources:	Assignment	Analysis and Verification	10 session
Topics: Edge Computing Fundamentals: Definition and importance of edge computing, Differences between edge and cloud computing, Advantages and challenges of edge computing. IoT Edge Node Components: Sensors and actuators, Microcontrollers and processors, Communication modules and protocols, Power management in edge nodes. Relevant Technologies of Edge Computing, Cloud-Hierarchy of Edge Computing-Business Models-Opportunities and Challenges in Federating Edge Resources, and Orchestration of Network Slices in 5G, Edge, and Clouds				
Module 4	Protocols, Middleware Software Patterns and user case study for Industrial Internet Systems:	Quiz	Application	10 session

Modern Communication Protocols-Proximity Network Communication Protocols- Wireless Communication Technologies- Gateways: industrial gateways - CoAP (Constrained Application Protocol)- NFC. Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS- Middleware Architecture- SigFox- LoRaWAN Augmented reality- Real-World Smart Factories, Application of IIOT: Case study: Health monitoring, IoT smart city, Smart irrigation, Robot surveillance.

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Smart Manufacturing	Edge node-based fault monitoring	Raspberry Pi, Node-RED	Industry 4.0
Precision Agriculture	Smart irrigation using edge nodes	Arduino, LoRaWAN	AgriTech
Smart Healthcare	Wearable health monitoring device	ESP32, MQTT	Healthcare
Smart Cities	Environment sensing edge node	NodeMCU, CoAP	Urban Development

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Design an IoT Edge Node for Temperature Monitoring	Understand sensor integration at the edge	Arduino IDE, DHT11 Sensor	Sensor interfacing, edge data acquisition, embedded system setup
Deploy MQTT-Based Messaging	Enable publish-subscribe communication	Mosquitto Broker, Node-RED	Message brokering, topic subscription, low-latency data flow
Simulate IIoT Gateway Connection	Visualize edge-cloud data flow	Packet Tracer, Node-RED	Protocol simulation, gateway interfacing, industrial communication architecture
Create Smart Irrigation Dashboard	Analyze real-time sensor data	ThingsBoard, Python	Data visualization, IoT dashboard design, real-time analytics

List of Laboratory Tasks: Nil

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.	2.0					
Course Pre-requisites	NIL					
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: CO1: Explain recent trends in computing such as Grid, Cluster, Distributed, Utility etc. (L2) CO2: Compare different computing paradigms (grid, cluster, distributed, utility, cloud) to select appropriate solutions for organizational needs. (L4) CO3: Analyze cloud computing architecture, service models (IaaS, PaaS, SaaS), and deployment models for different business requirements. (L4) CO4: Compare public cloud service providers (AWS, Azure, Google Cloud) and develop use cases for cloud migration strategies. (L4) CO5: Employ virtualization solutions using hypervisors and assess their impact on cloud infrastructure performance. (L3) CO6: Demonstrate the use of Platform as a Service (PaaS) and cloud storage services using simulation tools such as Google App Engine and EC2. (L3)			
Course Content:				
Module 1	Overview and Introduction of Computing	Assignment / Quiz	Implementation using Simulation tools	12 sessions
Topics: Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. Evolution of cloud computing - Business driver for adopting cloud computing. Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers. Properties, Characteristics & Disadvantages - Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing.				
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	Public Cloud Service Providers & Use Cases	Assignment / Quiz	Implementation using Simulation Tools	10 sessions
Topics: Service Providers: AWS, MS Azure, Google Cloud Platform, IBM Cloud. Use case related to organizations leveraging cloud computing platform / technology. Use case related to cloud migration depending upon environment.				
Module 4	Virtualization for Cloud	Assignment / Quiz	Implementation using Simulation Tools	10 sessions

Topics:
Need for vitalization, Pros & Cons of vitalization, Types, System Deployment, Networking, Load Balancing Hypervisors, KVM, VMware, Virtual Box

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 Velte T, Anthony, Velte J, Toby. "Cloud Computing-A Practical Approach", Tata McGraw Hill 2010.
2 Judith Hurwitz, R. Bloor, M. Kanfman, F. Halper. "Cloud Computing for Dummies", Wiley Publication Inc.3.

Reference(s):

1. Barry Sosinky. "Cloud Computing Bible", Wiley Publication Inc 2011.
2. John W. Rittinghouse, James F. Ransome. "Cloud Computing-Implementation, Management and Security", CRC Press, 2017.
3. K. Mehrotra, C. Mohan and S. Ranka, "Elements of Artificial Neural networks, MIT Press.

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

1.Free online course:- https://www.udemy.com/course/building-cloud-infrastructure-with-terraform/ , Coursera - https://www.coursera.org/learn/introduction-to-cloud
2. NPTEL Video content: NPTEL - https://onlinecourses.nptel.ac.in/noc22_cs20/preview
3. online Notes - https://www.coursera.org/learn/introduction-to-cloud,https://gpmeham.edu.in/wp-content/uploads/2020/09/E-NOTES_OF_CLOUD_COMPUTING-3.pdf
4.Online PPTs - https://www.slideshare.net/OECLIBOdishaElectron/cloud-computing-ppt-79142235

E-content:

1. S. Z. Mohammadi and J. N. Navimipour, "Invalid cloud providers' identification using the support vector machine," International Journal Of Next-Generation Computing, vol. 8, no. 1, 2017. https://ijngc.perpetualinnovation.net/index.php/ijngc/article/view/122

2. Q. Zhang, L. Cheng, and R. Boutaba, "Cloud computing: state-of-the-art and research challenges," Journal of internet services and applications, vol. 1, no. 1, pp. 7–18, 2010. https://jisajournal.springeropen.com/articles/10.1007/s13174-010-0007-6

3. K. A. Rodrigues de Castro, "Feasible community cloud architecture for provisioning infrastructure as a service in the government sector," in Proceedings of the 20th Annual International Conference on Digital Government Research, pp. 35–40, Dubai, United Arab Emirates, June 2019. https://www.researchgate.net/publication/360118887_Descriptive_Literature_Review_and_Cl

assification_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	Dr. Nishant Sharan
Recommended by the Board of Studies on	21st BOS held on 09/06/2025
Date of Approval by the Academic Council	Meeting No. 26th, Dated 25/07/2025

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: Describe the core architecture, essential terminology, and foundational concepts of IoT ecosystems. (L2) CO2: Distinguish between various IoT and M2M protocols and their respective application frameworks. (L3) CO3: Examine the role of big data, cloud computing and storage. (L3) CO4: Illustrate usage of Hadoop and data analytics application. (L3) CO5: Develop firmware on an ESP platform to collect, process, and analyze real-time data from external hardware components. (L4)					

	CO6: Assess the performance of data science workflows when applied to real-world IoT deployment scenarios.(L4)			
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):

1. HakimaChaouchi, "The Internet of Things Connecting Objects to the Web" ISBN: 978-1-84821-140-7, Wiley Publications.Edition-1
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", Wiley Publications. Edition-2

References:

1. 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 Du287, 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 Course Discipline 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.					
Course Outcomes	On successful completion of this course the students shall be able to: CO1: Explain the basic concepts of IIoT with business model, reference architecture and IIoT layers.(L2) CO2: Predict the requirements of IIoT big data analytics by utilizing machine learning, data science, and software-defined networks. (L3) CO3: Illustrate the predictive maintenance with IIoT technology and cyber physical systems. (L3)					

<table>
<tr><td></td><td colspan="4">CO4: Apply IoT gateway, IoT edge system programming, cloud computing, real-time data monitoring, data analytics, and predictive maintenance techniques in IIoT applications. (L3)

CO5: Apply Industrial IoT concepts in healthcare, power plants, inventory management, quality control, and facility management applications. (L3)

CO6: Apply IIoT technologies, UAVs, and AR/VR-based safety systems to solve industrial safety, security, and process management problems through real-world case studies. (L3)</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
1. Schneider Electric
2. Hewlett Packard
3. Ericsson
4. Oil and Gas Refineries
Professionally Used Software:
1. Exosite ExoSense IoT
2. AWS IoT SiteWise</td></tr>
<tr><td colspan="5">Text Book(s):
1. Sudip MIsra, Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0” , CRC Press, First Edition, 2021
2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things” , Apress, First Edition 2021.</td></tr>
<tr><td colspan="5">References
1. Giacomo Veneri Antonio Capasso, “Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0”, Packt Publishers, First Edition, 2018
2. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice” , 1st Edition, Wiley Publications 2010
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems” , 1st Edition, River Publishers 2013.
4. Hakima Chaouchi, “The Internet of Things Connecting Objects to the Web” ISBN: 978-1-84821-140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi.</td></tr>
</table>

Online Resources (e-books, notes, ppts, video lectures etc.): 1. NPTEL Course on "INTRODUCTION TO INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS" by Dr. Sudip Misra, IIT KGP https://nptel.ac.in/courses/106105195 2. NPTEL Course on "Introduction to internet of things, By Prof. Sudip Misra, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc20_cs66/preview **E-content:** 1. Athanasios Bachoumis; Nikos Andriopoulos; Konstantinos Plakas; Aristeidis Magklaras, "Cloud-Edge Interoperability for Demand Response-Enabled Fast Frequency Response Service Provision", IEEE Transactions on Cloud Computing, Volume: 10, Issue: 1, 01 Jan.-March 2022, pp: 123 - 133 https://ieeexplore.ieee.org/document/9560071/authors#authors 2. S. Z. Mohammadi and J. N. Navimipour, "Invalid cloud providers' identification using the support vector machine," International Journal Of Next-Generation Computing, Volume. 8, No. 1, 2017. https://ijngc.perpetualinnovation.net/index.php/ijngc/article/view/122 3. He Li, Kaoru Ota, Mianxiong Dong, "Learning IoT in Edge: Deep Learning for the Internet of Things with Edge Computing", IEEE Network, Volume: 32, Issue: 1, Feb. 2018, pp:96 - 101, DOI: 10.1109/MNET.2018.1700202, https://ieeexplore.ieee.org/document/8270639 4. Yao-Chung Chang, Ying-Hsun Lai, "Campus Edge Computing Network Based on IoT Street Lighting Nodes", IEEE Systems Journal, Volume: 14, Issue: 1, March 2020, pp:164 - 171, https://ieeexplore.ieee.org/document/8490873
Topics related to development of "SKILL DEVELOPMENT": IIoT Sensing, IIoT Processing, IIoT Communication. Topics related to development of "EMPLOYABILITY" : Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Catalogue prepared by	Mr. Tony Aby Varkey M Ms. Srilakshmi K H
Recommended by the Board of Studies on	BOS 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: 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: 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 Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Remote Patient Monitoring	Monitoring cardiac activity using wearable sensors	Smart ECG devices, BLE, IoT Cloud	Healthcare, Telemedicine
Emergency Response Systems	Fall detection for elderly using accelerometers	IMUs, GPS modules	Assisted Living, Elderly Care
Health Data Management	Encrypted health data transmission	Blockchain, Hyperledger	Medical IT Services

Chronic Disease Management	Blood glucose monitoring and reporting	Smart glucose meters, IoMT platform	Diabetes Care, mHealth

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Simulate IoMT-Based Cardiac Monitoring	Understand wearable IoMT system design	Logisim, Arduino, BLE	Signal acquisition, wireless data transfer, health sensor integration
Implement GPS-Enabled Accident Detection	Enhance location-aware emergency systems	GPS Module, Embedded C, GUI Frameworks	Real-time tracking, embedded alerts, geolocation interfacing
Develop GUI for Telemedicine Portal	Enable interactive remote diagnosis	Python-Tkinter, WebSockets	GUI programming, asynchronous communication, real-time health data interface

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.					

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

CO1: Explain the fundamentals of machine learning using supervised and unsupervised learning paradigms for model evaluation. (L2)
CO2: Apply regression models using statistical estimation techniques for predictive modeling. (L3)
CO3: Apply classification algorithms using decision boundaries and probabilistic learning methods for data classification. (L3)
CO4: Employ feature engineering and validation techniques for improving machine learning model generalization. (L3)
CO5: Utilize probabilistic and dimensionality reduction techniques for feature extraction and pattern analysis. (L3)
CO6: Apply artificial neural network architectures for solving pattern recognition and classification problems. (L3)</td></tr>
<tr><td>Course Content:</td><td colspan="4"></td></tr>
<tr><td>Module 1</td><td>Fundamentals Machine Learning</td><td>Assignment</td><td>Quizzes</td><td>13 Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to computational intelligence and machine learning, supervised and unsupervised machine learning, Supervised Machine Learning:- Regression:- Linear Regression, Polynomial Regression, Classification:- Logistic Regression, Decision Trees, K-Nearest Neighbor, Naive Bayes, Random Forest, Support Vector Machine (SVM), Performance metrics for regression and classification models, Training and test splits, Feature selection and engineering, Overfitting/Under fitting of a model and their causes, Regularization, k-fold cross validation, confusion matrix</td></tr>
<tr><td>Module 2</td><td>Unsupervised Machine Learning</td><td>Assignment/mini project</td><td>Quizzes</td><td>10 Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction to unsupervised machine learning, Clustering, Association, Dimensionality Reduction, Comparison of supervised and unsupervised machine learning, Clustering: -Hierarchical clustering, K- Means Clustering, Dimensionality Reduction:- Principal Component Analysis (PCA), Independent Component Analysis</td></tr>
<tr><td>Module 3</td><td>Building Recommender Systems</td><td>Assignment/mini project</td><td>Programing</td><td>16 Sessions</td></tr>
<tr><td colspan="5">Topics:
Introduction To Artificial Neural Networks (ANNs), Types of Neural Networks: Feedforward Neural Network (FNN), Recurrent Neural Network (RNN), Convolutional Neural Network (CNN), Perceptron, Ex-Or Problem, Multilayer perceptron, Relation Between The Perceptron And Bayes Classifier For A Gaussian</td></tr>
<tr><td>Module 4</td><td>Applications and Case Studies in Machine Learning</td><td>Assignment/mini project</td><td>Programing / simulation</td><td>06 Sessions</td></tr>
<tr><td colspan="5">Case Studies of machine learning and neural networks such as healthcare, manufacturing, defence, banking, marketing and many more.</td></tr>
<tr><td colspan="5">List of Laboratory Tasks: Nil</td></tr>
<tr><td colspan="5">Targeted Applications and Tools</td></tr>
</table>

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Medical Diagnosis	Disease prediction using ML classification	Python, Scikit-learn	Healthcare, Biotech

Finance Forecasting	Stock trend analysis	Python, TensorFlow	Finance, FinTech
Smart City Planning	Traffic pattern clustering	Matlab, Python	Urban Planning, Government
IoT & Automation	Sensor data classification	Python, Embedded ML Tools	Manufacturing, Automotive

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Implement Perceptron Model	Understand basic neural computations	Python, NumPy	Neural activation modeling, binary classification logic
K-Means on Real Dataset	Cluster data and evaluate inertia	Python, Scikit-learn	Clustering, unsupervised learning, elbow method application
Support Vector Machine Application	Classify and visualize decision boundaries	Python, Scikit-learn	Margin maximization, kernel methods, decision boundary visualization
Genetic Algorithm for Optimization	Explore evolutionary strategies	MATLAB, DEAP	Fitness evaluation, mutation/crossover logic, convergence analysis

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:** CO1: Explain the fundamental concepts of neural networks, including neuron models, learning paradigms, loss functions, and the limitations of traditional computing. (L2) CO2: Illustrate TensorFlow-based neural network workflows involving tensors, variables, computational graphs, and optimization concepts. (L3) CO3: Demonstrate the effect of activation functions, loss functions, and dimensionality on neural network learning behaviour. (L3) CO4: Illustrate the architecture and functional components of convolutional neural networks, including convolution, pooling, filters, and feature maps. (L3) CO5: Assess convolutional and sequence-based neural network models for feature extraction efficiency, architectural depth, and application suitability. (L3) CO6: Apply deep learning and reinforcement learning concepts to case studies in computer vision and healthcare applications. (L3)					
Course Content:						
Module 1	Introduction To Neural Networks	Quiz and assignments	20 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	16 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	9 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):

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

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.):

1. Introduction to Neural Networks | Engineering Education (EngEd) Program | Section
2. Introduction to the Artificial Neural Networks (semanticscholar.org)
3. Introduction to Neural Networks Basics (dataaspirant.com)
4. Microsoft PowerPoint - 1 - Intro.ppt (stir.ac.uk)
5. Index of /~tba3/stat665/lectures (yale.edu)
6. Introduction to Neural Network| Convolutional Neural Network (analyticsvidhya.com)
7. Course Notes: Idempotent Productions (stanford.edu)
8. NPTEL - https://nptel.ac.in/courses/117/105/117105084/
9. Artificial neural networks: a tutorial https://ieeexplore.ieee.org/abstract/document/485891
10. Artificial neural networks https://ieeexplore.ieee.org/abstract/document/8118
11. Python Machine Learning Tutorial (Data Science) - Bing video
12. 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: ECE3449	**Course Title: Applications of Deep Learning** **Type of Course Discipline Elective- Signal Processing Basket**		**L-T-P-C**	3	0	0	3
Version No.	2.0						
Course Pre-requisites	Basic concepts of statistics, algebra and matrix operations						
Anti-requisites	**NIL**						
Course Description	The purpose of this course is to enable the students to understand the theoretical concepts, algorithms and methodologies of Neural Networks, Deep Neural Networks, CNN, etc. The course also demonstrates the use of Python / MATLAB / SCILAB programming to develop classification applications using deep neural networks.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Applications of Deep Learning designed to improve the learner's Employability Skills by using Participative Learning Methodologies.						
Course Outcomes	**On successful completion of this course the students shall be able to:** CO1: Explain perceptron models, activation functions, backpropagation, optimization techniques, network width and depth, and the curse of dimensionality in deep learning. (L2) CO2: Apply activation functions, loss functions, backpropagation, and optimization techniques to train deep neural networks. (L3) CO3: Illustrate the architecture and operation of convolutional neural networks using layers, filters, parameter sharing, regularization, and performance metrics. (L3) CO4: Utilize transfer learning and classical CNN architectures to perform image learning tasks. (L3) CO5: Classify deep learning architectures based on their structural characteristics and application domains. (L3) CO6: Apply deep learning techniques for image classification, segmentation, and object detection in medical and agricultural applications. (L3)						
Course Content:							
Module 1	**Fundamentals of Deep Learning**	Quiz	Memory Recall based Quizzes	**12 sessions**			
Topics: The Perceptron - History, Discovery, and Theory, Multilayer Perceptron, Activation Functions: RELU, LRELU, ERELU Back-propagation algorithm and its variants, Width and Depth of Neural Networks, Curse of Dimensionality. Loss function, Optimization Techniques, Stochastic gradient decent							

Module 2	**Deep Learning Architecture**	Assignment / Quiz	Programming task	**12 session**
Topics: Introduction to Deep Learning, Comparison - Machine Learning and Deep Learning, Architectural Overview of CNN, Layers, Filters, various performance metrics for CNN, Parameter sharing, Regularization, Concept of Transfer learning, Unsupervised Training of Neural Networks, Ethical considerations while developing Deep Learning Models				
Module 3	**Variants of CNN**	Assignment	Memory Recall based Quizzes	**10 sessions**
Topics: Variants of CNN: LeNet, AlexNet, GoogleNet, ResNet, Highway Networks, PolyNet, YOLO, VGG, Inception, BLSTM, Deep Belief Networks.				
Module 4	**Applications of Deep Learning**	Assignment	Programming task	**09 session**
Topics: Deep Learning applications: Image Processing- Segmentation, Classification, object detection, Case studies from medical image processing, object detection, agricultural applications etc.				

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: Data analytics, Computer Vision - Image & Video Processing, Speech Recognition, Automatic machine translation, object detection etc.
Professionally Used Software: Anaconda/ pytorch or google colab, Jupyter Notebook on cloud/ MATLAB Deep Learning Toolbox

Text Book(s):

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

Reference(s):

Reference Book(s):

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

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

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

E-content:

1. Sergiu Oprea , Pablo Martinez-Gonzalez, Alberto Garcia-Garcia , John Alejandro Castro-Vargas, Sergio Orts-Escolano , Jose Garcia-Rodriguez , and Antonis Argyros, (2022, June). A Review on Deep Learning Techniques for Video Prediction. IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 44, NO. 6 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9294028
2. Qin Zou , Member, IEEE, Lihao Ni , Tong Zhang , and Qian Wang, "Deep Learning Based Feature Selection for Remote Sensing Scene Classification". In IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 12, NO. 11, NOVEMBER 2015. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7272047
3. Tsung-Han Chan, Kui Jia, Shenghua Gao, Jiwen Lu, Zinan Zeng, and Yi Ma, " PCANet: A Simple Deep Learning Baseline for Image Classification?", in IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 24, NO. 12, DECEMBER 2015

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7234886 4. Dionysis Goularas; Sani Kamis, "Evaluation of Deep Learning Techniques in Sentiment Analysis from Twitter Data" 2019, *International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*. https://ieeexplore.ieee.org/xpl/conhome/8870906/proceeding	
Topics relevant to "EMPLOYABILITY SKILLS": CNN, RNN, Applications of Deep Learning, for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.	
Catalogue prepared by	Mr. Kiran Dhanaji Kale
Recommended by the Board of Studies on	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: CO1: Compare data analytics, machine learning and deep learning algorithms in digital health using Artificial Intelligence (AI). (L2) CO2: Classify the data applicable to treatment pathway, diagnostics and health administration. (L3) CO3: Examine the patient, medicine and supporting pharma data using Artificial Intelligence (AI). (L3) CO4: Infer the role of Artificial Intelligence (AI) in medical robots, empathy and Human Resources' (HR) crisis. (L4) CO5: Interpret the values of evidence-based medicine and personalized medicine in improving the health outcomes. (L3) CO6: Apply connected medicine technologies for disease and condition management in healthcare systems. (L3)					
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 Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Early Diagnosis	Develop CNN for X-ray image classification	Python, TensorFlow, Keras	Medical Imaging, Radiology
Precision Medicine	Design AI recommender system for treatment	Scikit-learn, Pandas	Genomics, Oncology
Remote Monitoring	IoT & AI-based wearable for vitals	Arduino, EdgeML	Telemedicine, Elderly Care
Health Records	Create NLP model for EHR summarization	spaCy, BERT	Health IT, Hospital Management

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Implement medical chatbot	Health assistance through NLP	Python, Dialogflow	Conversational modeling, NLP intent mapping
X-ray classification model	Diagnose pneumonia using CNN	Keras, TensorFlow	Medical image classification, CNN fine-tuning
Create GUI for patient database	Patient data management system	MySQL, Python Tkinter	Database GUI design, health data handling

Drug discovery with ML	Predict drug-likeness	AutoML, Scikit-learn	Drug screening, classification, model automation

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/9332458 Other 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 Electives

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.

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Embedded Systems	LED Interfacing & Memory Access	Emu8086, Proteus	Consumer Electronics
Automation	Peripheral Device Control using 8255	Keil µVision, Multisim	Industrial Automation
Data Acquisition	Interrupt-driven I/O system	Multisim, Arduino IDE	Instrumentation
Smart Devices	Timer based scheduling with 8254	Proteus VSM	IoT and Embedded Startups

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Assembly program to add numbers	Understand assembly-language structure	Emu8086	Instruction-level coding; debugging
Memory interface design	Develop RAM/ROM access	Proteus	Memory mapping; hardware interfacing
LED toggle with 8255	Explore peripheral control	Multisim	Parallel I/O programming; hardware control
Timer-based interrupt	Perform time-critical task scheduling	Emu8086 + Proteus	Interrupt handling; real-time scheduling

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: 4. 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 5. 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 6. 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 7. 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 8. 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 Teachable

List of Laboratory Tasks:
NA

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Healthcare	Disease prediction from patient data	Python (ANN, Keras)	Healthcare, Biomedical
Finance	Stock market trend prediction	MATLAB, Python	FinTech, Banking
Retail	Customer segmentation and recommendation	Python, TensorFlow	E-Commerce, Retail
Agriculture	Crop disease detection	Python, OpenCV, CNN	AgriTech, Startups
Security	Face recognition and surveillance	Python, Deep Learning	Surveillance, Cybersecurity

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Iris flower classification	Classify flower species using ANN	Python (scikit-learn), Jupyter Notebook	Pattern recognition; supervised learning
MNIST digit recognition	Recognize handwritten digits	TensorFlow/Keras	Image classification; deep learning
Stock price prediction	Predict stock trends	Python, pandas, Keras	Time-series forecasting; regression models
Music genre classification	Identify music genres from audio	Python, Librosa, ANN models	Audio feature extraction; multi-class classification
XOR gate simulation	Simulate XOR logic with MLP	MATLAB/Python	Logic gate modelling; neural computation

Project work/Assignment:

1. Sample Project works - Iris Flowers Classification Project, MNIST Digit Classification Machine Learning Project, Stock Price Prediction using Machine Learning, Wine Quality Test Project, Music Genre Classification Machine Learning Project, Handwritten Character Recognition

2. Sample Assignments -

i. You went to an agriculture farm which cultivates vegetables. Identify any three problems which can be solved by machine learning and mention the steps of database preparation and training the models.

ii. Implement the perceptron model of a two-input XOR gate in MATLAB/ Python and verify the structure using the truth table.

iii. Please visit the college library or e-resource and find the below Journal and submit the report for the following paper (Attach the title of the journal and the paper)

iv. A single layer n/n is given with two input values [x1 x2]=[0.05 0.10]; and initial weights as w1=0.15 w2= 0.20 w3= 0.25 w4= 0.30 w5=0.40 w6=0.45 w7=0.50 w8=0.55; bias value as b1=0.35 b2=0.60; target value T1=0.01, T2=0.99. Show the steps for both forward and backward pass at the output layer.

3. Book/Article review: At the end of each module a book reference or an article topic will be given to an individual or a group of students. They need to refer the library resources and write a report on

their understanding about the assigned article in appropriate format. Presidency University Library Link .
Text Book(s): 1 Simon Haykin, "*Neural Networks and Learning Machines*", Pearson. Reference Book(s) 1. C. Bishop, “Neural Networks for Pattern Recognition” , Oxford University Press. 2. K. Mehrotra, C. Mohan, and S. Ranka, *"Elements of Artificial Neural Networks"*, MIT Press 3. Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition) by Eric Matthes
Online Resources (e-books, notes, ppts, video lectures etc.): 1. Introduction to ANN (NPTEL) - https://nptel.ac.in/courses/117/105/117105084/ 2. Artificial Intelligence Courses (Udemy) - https://www.udemy.com/topic/artificial-intelligence/ 3. Supervised Machine Learning: Regression and Classification by Dr. Andrew Ng (Coursera) - https://www.coursera.org/learn/machine-learning E-content: **1.** Ciregan, D., Meier, U., & Schmidhuber, J. (2012, June). Multi-column deep neural networks for image classification. In 2012 IEEE conference on computer vision and pattern recognition (pp. 3642-3649). IEEE. - https://ieeexplore.ieee.org/abstract/document/6248110 **2.** W. Lin and G. Chen, "Large Memory Capacity in Chaotic Artificial Neural Networks: A View of the Anti-Integrable Limit," in *IEEE Transactions on Neural Networks*, vol. 20, no. 8, pp. 1340-1351, Aug. 2009, doi: 10.1109/TNN.2009.2024148. - https://ieeexplore.ieee.org/document/5166455 **3.** K. B. Lee and H. S. Shin, "An Application of a Deep Learning Algorithm for Automatic Detection of Unexpected Accidents Under Bad CCTV Monitoring Conditions in Tunnels," *2019 International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*, 2019, pp. 7-11, doi: 10.1109/Deep-ML.2019.00010. https://ieeexplore.ieee.org/document/8876906 **4.** D. Goularas and S. Kamis, "Evaluation of Deep Learning Techniques in Sentiment Analysis from Twitter Data," *2019 International Conference on Deep Learning and Machine Learning in Emerging Applications (Deep-ML)*, 2019, pp. 12-17, doi: 10.1109/Deep-ML.2019.00011. https://ieeexplore.ieee.org/document/8876896
Topics relevant to “ENTREPRENEURIAL SKILLS” : Applications of ANN for developing Entrepreneurial Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms Anupama S, Mr. Arvind Kumar
Recommended by the Board of Studies on	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	NA
Anti-requisites	NIL
Course Description	This course introduces the integration of electronics, embedded systems, and digital technologies in the field of agriculture to enhance productivity, sustainability, and efficiency. It provides students with a comprehensive understanding of how sensors, IoT, microcontrollers, cloud platforms, and data analytics can transform traditional agricultural practices into smart, data-driven, and automated systems. Students will explore fundamental concepts of precision agriculture, hydroponics, automation, and renewable energy-based systems while gaining insights into real-world applications such as smart irrigation, crop monitoring, livestock management, and agri-robots. The course emphasizes the role of embedded electronics, IoT communication protocols, cloud computing, and AI in building scalable smart agriculture ecosystems. Through theoretical foundations, case studies, and conceptual system design, learners will develop the ability to design and evaluate end-to-end smart agriculture solutions that leverage modern electronic and computing technologies for sustainable and digital agricultural development.
Course Objective	This course is designed to develop <u>ENTREPRENEURIAL SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques.
Course Outcomes	On successful completion of this course the students shall be able to: **CO1:** Explain the evolution of agriculture from traditional to modern systems and describe the role of electronics and digital technologies in transforming agricultural practices. **CO2:** Identify and describe various agricultural sensors, actuators, microcontrollers, and communication protocols used in smart farming applications. **CO3:** Design and demonstrate basic IoT-based architectures and embedded systems for monitoring and automation in agricultural environments. **CO4:** Apply concepts of cloud computing, IoT, and data analytics to develop integrated smart agriculture solutions for improved decision-making. **CO5:** Analyze case studies to evaluate the socioeconomic, environmental, and technological impacts of smart electronics and digital transformation in agriculture.
Course Content:	

Module 1	Foundations of Smart Agriculture and Electronics	QUIZ	Comprehension level Quiz	14 classes

Topics:
Overview of Indian and Global Agriculture, The Green Revolution: Evolution and Technological Impacts, Methods of Agriculture: Traditional vs. Modern Approaches ,Role of Technology in Modern Agriculture, Introduction to Electronics in Agriculture ,Overview of Fertilizer, Pesticide, and Irrigation Technologies, Introduction to Sensors and Their Importance in Agriculture, Fundamentals of Data in Agriculture (Big Data Concepts),Introduction to Precision Agriculture, Basics of Hydroponics and Alternative Farming Methods, The Importance of Digital Transformation in

Agriculture, Role of Data Analytics in Agricultural Decision-Making, Introduction to Smart Agriculture Ecosystem				
Module 2	Core Smart Electronics and Embedded Technologies	Case Study	Sensor and Embedded system	15 classes
Topics: Types of Sensors and Actuators Used in Agriculture, Principles of Agricultural Sensors (Soil, Moisture, Temperature, etc.), Selection, Placement, and Calibration of Sensors, Introduction to Embedded Systems in Agriculture, Microcontrollers (e.g., Arduino): Architecture, Programming, and Interfacing, Communication Protocols for Sensor Networks (Wired/Wireless Basics),Introduction to IoT in Agriculture: Concepts and Architecture Platform Overview; Device-to-Device and Device-to-Cloud Communication, Fundamentals of Edge and Fog Computing (Essentials Only; Complexities Reduced), Introduction to IoT Communication Protocols (MQTT, CoAP - Basic Application), Security and Privacy Concerns in Smart Agriculture, Introduction to Cloud Computing in Agriculture (Focus: SaaS Applications), Cloud Service Providers: Basic Overview (Google Cloud, etc.) ,RFID and Simple Actuator Controls in Agri-context (Focus on Integration Principles)				
Module 3	Applications, Integration, and Case Studies	Mini Project	System Design Task and Analysis	14 Classes
Topics: System Design Concepts for Smart Agriculture (Theory/Case-based),End-to-End IoT System Example for Agriculture, Smart Monitoring Systems: Crop, Environment, and Equipment, Automation in Irrigation and Greenhouses (Scenario-Based), Role of Renewable Energy in Smart Agriculture (Overview; Solar-Powered Devices), AI and Data Analytics Applications in Agri IoT (Introductory Concepts), Challenges of Scaling Smart Agriculture: Infrastructure and Societal Barriers, Urban Farming and Smart City Applications: E-Agriculture Overview, Introduction to Agribots (Emphasis on Sensors and Simple Robotics Theory),Aquaculture and Livestock Monitoring using Electronics (Essentials), Digital Transformation & Future Trends in Smart Agriculture, Socioeconomic and Environmental Impacts of Smart Electronics in Agriculture, Course Summary, Review, and Case Discussion (Recent Success Stories)				

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Agriculture	Climate monitoring system	Arduino, DHT11, MQTT	AgriTech
Aquaculture	Fish tank condition monitor	NodeMCU, pH sensor	Fisheries
Urban Farming	Hydroponic nutrient controller	ESP32, Relay Modules	Smart Cities
Smart Irrigation	Soil moisture sensing system	Raspberry Pi, Soil Sensors	Rural Automation

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Design IoT-based smart irrigation	Automated irrigation	Arduino, soil sensor, relay	Sensor interfacing; IoT control
Build weather data logger	Monitor temperature/humidity	DHT11, ESP32, cloud APIs	Data logging; cloud integration
Create fish farm monitor	pH/temperature control	NodeMCU, pH sensor	Aquaculture monitoring; real-time feedback
Remote farm camera setup	Visual crop inspection	ESP32-CAM, web app	Remote imaging; web-based control

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. Rajesh Singh, Anita Gehlot, Bhupendra Singh, Sushabhan Choudhury Routledge"Internet of Things (IoT) Enabled Automation in Agriculture"
CRC Press (Taylor & Francis),2023

3. Sheetanshu Gupta, Wajid Hasan, Shivom Singh, Dhirendra Kumar, Mohammad Javed Ansari, Shabistana Nisar "Agriculture 4.0: Smart Farming with IoT and Artificial Intelligence" CRC Press/Taylor & Francis, 2024 (1st ed)

4. 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:-

2 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

3 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

4 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 5 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 provides students with deep knowledge of sensors and data acquisition systems to monitor atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems. The course also provides students with deep knowledge of importance of single board computers and data loggers.							
Course Objective	The objective of the course is SKILL DEVELOPMENT of student by using PARTICIPATIVE LEARNING techniques							
Course Outcomes	On successful completion of this course the students shall be able to: (1) Describe the concepts of continuous real time monitoring systems with Internet of Things. (2) Understand constraints and opportunities of single board computers. (3) Describe the various setup to monitor and measure the data collected from environment. (4) Able to design and perform experiments on sensors and develop the projects based on the customer needs.							
Course Content:								
Module 1	Introduction	Quiz	Memory Recall based Quizzes	10 Sessions				

Topics: Environmental systems, Echo systems and planet earth. Human Interaction with the environment, from measuring to knowing, continuous real time monitoring, data management and World Wide Web. Sampling, Ground based, airborne and spaceborne systems.				
Module 2	From Sensors to systems.	Assignment / Quiz	Memory Interfacing Task and Analysis	12 Sessions
Topics: Sensors and transducers: Principles of electrical quantities, circuits,sensor specifications, from sensors to transducers, case studies:from light sensors to a light transducers, from thermistor to temperature tranducers,temperature transducres for air,soil and water.Thermocouples,using thermocouples.				
Module 3	Data Acquisition systems	Assignment	Memory Interfacing Task and Analysis	10 Sessions
Topics: Introduction to data loggers, applications in environment monitoring, analog channels, Real time clock, communications with datalogger, RS-232 standard, single board computers, ARM Architectures				
Module 4	Applications	Assignment	Programming and Simulation task.	09 Sessions
Topics: Atmospheric Process, water resources, terrestrial ecosystems and wildlife monitoring systems				

Targeted Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Air Quality Monitoring	Developing a PM2.5 and gas-level sensing system	Arduino, MQ Sensors	Smart Cities, Pollution Boards
Water Quality Testing	Automated pH and turbidity monitoring	pH Sensor, Raspberry Pi	Agriculture, Water Supply Depts.
Wildlife Tracking	GPS-enabled animal movement tracker	LoRa, GPS Module	Conservation Agencies
Soil Monitoring	Soil moisture and temperature sensing for farms	ESP32, DHT11	AgriTech, Climate Research

Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Build an air-pollution sensor node	Understand sensor interfacing and air-quality measurement	Arduino + MQ135 + OLED	Gas-sensor integration; AQI measurement
Log soil temperature with RTC	Acquire time-tagged data from analog sensors	ESP32 + RTC + DHT11	Time-synchronized sensing; data acquisition
Create a web-based dashboard	Visualize live sensor data remotely	Python Flask, ThingSpeak	Web application development; data visualization
Deploy a water-monitoring system	Collect real-time pH/turbidity levels	Raspberry Pi, pH & turbidity sensors	Water-quality sensing; sensor fusion

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.): 1. Ambient assisted living and enhanced living environments: principles, technologies and control Ciprian Dobre, First Edition < https://www.elsevier.com/books/ambient-assisted-living-and-enhanced-living-environments/dobre/978-0-12-805195-5 > 2. Introduction to wearable technologies <https://www.mdpi.com/books/pdfdownload/book/1088 > 3. Case studies on Wearable technology< https://www.hticiitm.org/wearables> E-content: **1.** Air Sampling Instruments for Evaluation of Atmospheric Contaminants (ISBN-13: 978-1882417087. **2.** Standard Methods for the Examination of Water and Wastewater, 21st Ed. 2005 APHA, AWWA. https://www.worldcat.org/title/standard-methods-for-the-examination-of-water-and-wastewater/oclc/156744115. **3.** R. Maheswar, P. Jayarajan, S. Vimalraj, G. Sivagnanam, V. Sivasankaran and I. S. Amiri, "Energy Efficient Real Time Environmental Monitoring System Using Buffer Management Protocol," 2018, pp. 1-5, doi: 10.1109/ICCCNT.2018.8494144. https://ieeexplore.ieee.org/document/8494144. 4. F. Sánchez-Rosario *et al*., "A low consumption real time environmental monitoring system for smart cities based on ZigBee wireless sensor network," *2015*, pp. 702-707, doi: 10.1109/IWCMC.2015.7289169. https://ieeexplore.ieee.org/document/7289169.
Topics relevant to development of "SKILL" : System design for environmental monitoring systems.

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

Academic Council	

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 <u>ENTREPRENEURIAL SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify the devices and system functions 2. Classify the components in electronics 3. Demonstrate and explain the house hold appliances					
Course Content:						

Module 1	Audio Fundamentals, Devices & Systems	Assignment/ Quiz	Memory Recall based Quizzes	15 Sessions
Topics: Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types. Basic characteristics of sound signal, Audio level metering, decibel level in acoustic measurement, Microphone & Types, speaker types & working principle, Sound recording principle & types.				
Module 2	Television Fundamentals	Assignment/ Quiz	Real time Application Project	15 Sessions
Topics: Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution, Composite video signal, Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance, Different types of TV camera, Transmission standards. PAL-D colour TV receiver, Digital TVs:- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver, Video interface, Digital Video, SDI, HDMI Multimedia Interface , Digital Video Interface, CD and DVD player.				
Module 3	Home / Office Appliances	Assignment/ Quiz	Memory Recall based Quizzes	10 Sessions
Home Appliances: Inverter, Microwave oven, Domestic Refrigerator, Controls in Refrigerator, Room Air Conditioning. Office Appliances: Calculator, Facsimile (FAX) and Pager.				

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Audio Systems	Diagnose stereo speaker issues	Multisim, Oscilloscope	Entertainment, Automotive
Television Systems	Test video signal quality	HDMI Analyzer	Broadcasting, Retail
Home Appliances	Repair inverter system	Multimeter, Simulation	Home Electronics
Office Devices	Fix fax machine signal routing	Signal Tracer	Business Automation

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Disassemble audio system	Understand component functions	Hands-on tools, Multisim	Component identification; circuit tracing
Colour-TV signal test	Assess video signal integrity	Oscilloscope, DSO	Signal analysis; video troubleshooting
Fix microwave oven	Repair common faults	Practical exposure, test bench	Fault diagnosis; safety procedures
Smartphone-controlled device	Bluetooth interface control	Arduino, Android app	Wireless control; IoT integration

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:

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 Applications and Tools

Application Area	**Hands-on Application Problem**	**Tools Utilised**	**Relevant Industries**
Consumer Electronics	Design an ergonomic audio speaker system	Fusion 360, TinkerCAD	Appliance, Audio
Smart Devices	PCB Design for IoT-based temperature monitor	OrCAD, Eagle	IoT, Home Automation
Wearables	Compact, aesthetic fitness tracker mock-up	SolidWorks, 3D Printing	Healthcare, Fitness

Power Devices	Design EMI-protected SMPS module	LTSpice, MATLAB	Energy, Industrial Electronics

Skill Building Through Experiential Learning

Activity / Task	**Objective**	**Tools / Technologies Used**	**Skills Developed**
Simulate & design audio-amplifier PCB	Understand PCB design flow	OrCAD, Proteus, KiCAD	PCB schematic capture; layout design
Prepare ergonomic product mock-up (e.g. mouse)	Apply ergonomic/aesthetic principles	Fusion 360, 3D printing	Industrial design; rapid prototyping
Reliability analysis of power-supply circuit	Estimate MTBF and analyse faults	MATLAB, LTSpice	Reliability engineering; failure analysis

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.):

7. 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

8. 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 9. 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 10. 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: 4. 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 5. 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 6. 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 7. 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 8. 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 9. 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 10. 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

Course Code: ECE3807	Course Title: Introduction to Data Analytics Type of Course: Open Elective Theory	L- T-P-C	3	0	0	3
Version No.	1.0					

<table>
<tr><td>Course Pre-requisites</td><td colspan="4">Probability and Statistics</td></tr>
<tr><td>Anti-requisites</td><td colspan="4">NIL</td></tr>
<tr><td>Course Description</td><td colspan="4">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="4">This course is designed to develop <u>ENTREPRENEURIAL SKILLS</u> by using <u>EXPERIENTIAL LEARNING</u> techniques.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">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="4"></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>
<tr><td>Module 3</td><td>Statistics, data, and Statistical Thinking</td><td>Assignment</td><td>Programming, Analysis and Visualization</td><td>8 classes</td></tr>
<tr><td colspan="5">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</td></tr>
<tr><td>Module 4</td><td>Machine Learning with scikit-learn</td><td>Assignment</td><td>Programming, Analysis and Visualization</td><td>9 classes</td></tr>
<tr><td colspan="5">Topics:</td></tr>
</table>

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)

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilised	Relevant Industries
Retail Analytics	Sales data cleaning and forecasting	pandas, matplotlib	E-commerce
Financial Markets	Stock price trend analysis	NumPy, seaborn	Banking/Finance
Healthcare	Patient data visualization	Python dashboards	HealthTech
Social Media	Sentiment analysis on tweets	NLTK, scikit-learn	Media & Marketing

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Data-cleaning assignment	Apply preprocessing techniques to real data	Python, pandas	Data wrangling; data quality improvement
Visualization project	Build interactive dashboards	matplotlib, seaborn, plotly	Data visualization; dashboard design
Model-building exercise	Create and test ML models	scikit-learn, Jupyter	Machine-learning modelling; evaluation
Group presentation	Evaluate analytics applications in domains	Case study, PPT	Communication; critical analysis

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: 1) Explore various vision systems for Machines 2) Understand the image capturing and processing techniques 3) Apply the robotic operating system to Machines		
Course Content:			
Module 1	Overview of Machine Vision in IP	Quizzes and assignments	12 SESSION
Topics: Basic Components - Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics - Cameras - Camera-Computer interface- Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours - Image Enhancement : Gray value transformations, image smoothing, Fourier Transform - Geometric Transformation - Image segmentation - Segmentation of contours, lines, circles and ellipses - Camera calibration - Stereo Reconstruction- Object recognition, Approaches to Object Recognition, Recognition by combination of views - objects with sharp edges, using two views only, using a single view, use of depth values.			
Module 2	Vision algorithms and applications	Quizzes and assignments	12 SESSION
Topics: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.			
Module 3	ROBOT Vision	Quizzes and assignments	12 SESSION
Topics: Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package			

Targeted Applications and Tools

Application Area	Hands-on Application Problem	Tools Utilized	Relevant Industries
Unmanned Vehicles	Stereo vision mapping	ROS, OpenCV, Python	Autonomous Systems
Smart Surveillance	Real-time object tracking	TensorFlow, OpenCV	Security, Défense
Healthcare Robotics	Tracking surgical instruments	MATLAB, Keras	Medical Devices
Manufacturing Automation	Object detection on assembly lines	PCL, PyTorch	Industrial Robotics

Skill Building Through Experiential Learning

Activity / Task	Objective	Tools / Technologies Used	Skills Developed
Shape-from-shading reconstruction	Understand 3D surface estimation	MATLAB, Python	3D vision; surface reconstruction
ROS camera driver integration	Real-time image processing with robots	ROS, OpenCV	ROS integration; real-time vision processing
Book/article review	Build analytical reading skills	Library research	Technical literature review; critical thinking
Group presentation on vision task	Collaborative learning & technical discussion	PowerPoint, demonstration	Teamwork; communication of vision algorithms

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	15^{th} BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18^{th} , Dated 03/08/2022

MAC Basket

Course Code: PPS1025	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 graduates to develop foundational communication and self-management skills essential for academic success, professional networking, and personal effectiveness. They will be able to initiate and maintain positive interactions, set and achieve goals efficiently, and communicate professionally in written form.					
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 Distinguish between phatic and informative communication CO 2 Illustrate the components of a SMART goal using personal or academic examples CO3 Apply standard email etiquette practices to compose professional and context-appropriate emails					

Course Content			
Module 1	Phatic Communion & Networking	Classroom activities	10 Hours
Phatic Communion & Networking Subtopics: 1. Small talks - Mastering Conversations 2. Networking for Changing Times 3. Elevator Pitch 4. Evaluation (Elevator Pitch)			
Module 2	The Power Trio: S.W.O.T, S.M.A.R.T Goals and Habits	Role plays	10 Hours
The Power Trio: S.W.O.T, S.M.A.R.T Goals and Habits Subtopics: 1. Personal SWOT analysis 2. The Power of Habits & Habit Loop 3. Crafting Your Academic & Personal SMART Goals 4. Evaluation (Video on S W O T & SMART Goal worksheet)			
Module 3	Email Etiquettes	Individual and group presentation	10 Hours
Inbox Impact: Email Etiquette Subtopics: 1. Email Etiquette Basics 2. Email Mishaps - Identify & correct mistakes 3. Introduction to AI Writing Prompts 4. AI Email Writing Challenge (Real time drafting of AIAssisted Email			
Faculty: L&D			
Targeted Application & Tools that can be used: 1. TED Talks 2. You Tube Links 3. Activities			
REFERENCE MATERIALS: A. Reference Books (For Module 1): 1. Soft Skills - Enhancing Employability: Connecting Campus with Corporate" by M S Rao 2. Everyone Communicates; Few Connect: What the Most Effective People Do Different Hardcover B. Reference Books (For Module 2): 3. Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones by James Clear 4. Goals! by Brian Tracy, 2018 5. S.M.A.R.T Goals –made simple by SJ Scott C. Movies recommended. My Fair Lady – 1964, The Intern – 2015 D. Videos to watch on Module 1. 1. Phatic Communication pt1 2. How to communicate confidently ? #learnenglish #janhavipanwar #speaking #communication			
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: **ENG2030**	**Course Title:** **Communication in Practice** **Type of Course:** **Integrated**	**L-T-P-C**	1	0	2	2
Version No.	1.0					
Course Pre-requisites	ENG1030– Fundamentals of Communication (Semester I)					
Anti-requisites	NIL					
Course Description	*Communication in Practice* is the second-semester course in sequence designed for first-year undergraduate students in engineering and computer science programmes. This course puts those foundations under professional pressure. The question is no longer *what* communication is, but *how* to deploy it when it counts: in a job interview, a pitch to a client, a negotiation with a colleague, a professional report directed at a real reader, or a leadership communication challenge that affects a team. The course is organised around four modules, each of which explicitly upgrades the work done in semester one. Assessment is 100% Continuous Assessment. There is no end-semester examination. The centrepiece is a capstone Professional Communication Portfolio that the student could realistically share with an employer.					
Course Objective	The course aims to articulate the foundational tenets of professional communicative identity, discourse ethics, and analytical text evaluation and apply them to high-stakes institutional scenarios and complex professional ecosystems. It also focuses on cultivating advanced oral communication strategies and persuasive vocal mechanics, including structured rhetorical delivery and spontaneous adaptive responses, for collaborative, hierarchical, and leadership contexts. Furthermore, it aims to refine technical authorship capabilities and artificial intelligence-mediated workflows to produce precise, highly structured, and audience-centric professional artifacts across formal engineering, computational, and cross-functional corporate domains.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 6. **Explain** the principles governing professional communication identity, communicator ethics, and context-sensitive self-presentation across workplace, hierarchical, and digital contexts. 7. **Demonstrate** advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches, negotiations, and leadership scenarios.					

<table>
<tr><td></td><td colspan="4">

8. **Demonstrate** advanced vocal, rhetorical, and adaptive strategies across high-stakes spoken communication genres, including interviews, pitches, negotiations, and leadership scenarios.
9. **Execute** the production of professional-grade written artifacts across high-demand genres—including formal reports, business proposals, data communications, and advocacy briefs—meeting real-world standards of clarity, structure, and audience appropriateness.
10. **Implement** AI-assisted communication workflows in professional contexts, including systematic prompt design for high-stakes outputs, validation protocols for synthetic materials, and the application of ethical frameworks at individual and organizational levels.

</td></tr>
<tr><td colspan="5">Course Content: Communication in Practice</td></tr>
<tr><td>Module 1</td><td>Words that Work: Vocabulary, Register, and Precision</td><td>CA1</td><td>Register Switching Activity</td><td>09 Sessions</td></tr>
<tr><td colspan="5">

The topics will be explored through vocabulary games, role-play activities, communication challenges, case-based tasks, and workplace simulations:

- Why Words Matter in Professional and Technical Communication
- Choosing the Right Words for Different Situations
- Understanding Meaning: Positive, Negative, and Neutral Word Choices
- Commonly Confused Words and Miscommunication in Professional Contexts
- Using Clear, Precise, and Concise Language
- Explaining Technical Terms to Non-Technical Audiences
- Building and Using Personal/Professional Vocabulary

</td></tr>
<tr><td>Module 2</td><td>Listening, Processing, and Structured Response Writing</td><td>CA2</td><td>Rapid Listening and Response</td><td>12 Sessions</td></tr>
<tr><td colspan="5">

The topics will be explored through podcasts, interviews, workplace recordings, collaborative listening tasks, discussions, and real-time writing activities:

- Identifying Key Information from Spoken Inputs
- Organizing Information from Discussions and Conversations
- Converting Spoken Communication into Clear and Structured Written Responses
- Writing Summaries from Audio and Discussion Inputs
- Writing Follow-Up Responses Based on Spoken Communication
- Writing Action Notes, Instructions, and Task Updates from Listening Inputs
- Converting Meetings and Discussions into Structured Written Outputs

</td></tr>
<tr><td>Module 3</td><td>High-Stakes Spoken Communication</td><td>CA</td><td>Mock Professional Interview, Pitching an Idea Pitch</td><td>12 Sessions</td></tr>
<tr><td colspan="5">

- Speaking as a professional: identity, presence, and the first impression
- Vocal authority, physical presence, and communication across hierarchies
- Interview communication: structure, composure, and the STAR framework
- Pitching ideas: the 3-minute and 10-minute pitch architecture
- Negotiation and principled disagreement

</td></tr>
</table>

• Communicating in leadership positions: chairing, facilitating, and giving direction • Managing communication under pressure: hostile questions, silence, and contradiction				
Module 4	**Adaptive Communication**	**CA**	**Communication Strategy Plan**	**12 Sessions**

The topics will be explored through leadership simulations, AI-assisted scenario practice, ethical debate exercises, case analysis, peer feedback sessions, and reflective portfolio activities:

- Communication Strategy: Audiences, Channels, Timing, and Feedback Loops
- What Emotional Intelligence Actually Does in High-Stakes Conversations
- Reading the Room: Adapting Style Across Personalities, Contexts, and Power Gaps
- Giving and Receiving Developmental Feedback as a Professional Practice
- Navigating Difficult Conversations: Disagreement, Criticism, and Bad News
- Repairing Communication Breakdowns: Apology, Accountability, and Recovery
- AI as a Strategic Communication Tool: Capabilities, Limits, and What Professionals Must Decide

Targeted Application & Tools that can be used: Otter.ai, Microsoft Word/PowerPoint/Teams/Clipchamp/Whiteboard/OneNote/Forms/Copilot, Miro, Padlet, Canva, Mentimeter, AllSides Media Bias Ratings, Ad Fontes Media Bias Chart, Snopes/factcheck.rog, Zotero, NotebookLM, Canva, Adobe Express, CapCut, OBS Studio, Claude, ChatGPT, Gemini, DeepSeek, Google Docs

Project Work / Assignment:

1. Register Switching Activity (Individual): Students receive a single professional scenario and must communicate the same core message to three different audiences — a peer, a manager, and a non-specialist outsider — switching register, vocabulary, and tone appropriately for each. Delivered live in class. Graded on accuracy of register shift, vocabulary choices, and adaptability under in-the-moment feedback from the assessor.

2. Word in the Wild Log (Individual): Over four weeks, students maintain a running log of 25 words or phrases encountered in professional contexts — podcasts, workplace conversations, news, interviews — that they did not fully understand or could not have used confidently themselves. For each entry, students record the source, the meaning in context, an alternative they might have used, and one original sentence demonstrating precise use. Submitted as a structured document at the end of Module 1. Graded on range, contextual accuracy, and quality of reflection.

3. Rapid Listening and Response (Individual): Students listen to an unedited workplace audio recording — a meeting excerpt, a briefing, or a professional conversation — played once, without transcripts. Under timed conditions, they produce a structured written response that captures key information, identifies the communication purpose, and drafts an appropriate follow-up action note. Graded on accuracy, organisation, and quality of written response.

4. Mock Professional Interview (Individual): Each student undergoes a 10-minute mock professional interview conducted by faculty or a peer panel. No prepared scripts permitted. Graded on composure, structure, vocal authority, and use of the STAR framework. Written self-evaluation of 200 words submitted within 48 hours.

5. Idea Pitch (Individual): Students deliver a 3-minute pitch of a solution to a real or simulated professional problem, to a panel that includes at least one hostile or sceptical questioner.

Immediately after the pitch, the panel asks two minutes of unscripted questions. Graded on clarity of argument, persuasive structure, handling of pressure, and vocal presence.

6. Difficult Conversation Simulation (Pair): Pairs of students are assigned roles in a scripted conflict scenario — a performance issue, a missed deadline, a broken professional agreement. Each student must navigate the conversation toward a constructive resolution without a script. Immediately after, both students complete a structured individual debrief identifying what communication choices they made, what they would change, and what they observed in their partner. Graded individually on communication behaviour during the simulation and quality of the debrief.

7. Communication Strategy Plan — Presentation and Portfolio Submission (Group): Students select a real or realistic professional scenario — a team conflict, a stakeholder disagreement, a leadership announcement, or a crisis communication moment. They develop a communication strategy plan that maps the audience, chooses appropriate channels and timing, anticipates likely responses, and identifies where AI tools could assist and where they must not. The plan is delivered as a 5-minute structured presentation to a simulated panel, followed by two minutes of unscripted Q&A. The portfolio submission includes the written plan, a one-page reflection on their communication growth across all four modules, and one piece of evidence from each module that demonstrates that growth. Graded on strategic thinking, clarity of presentation, quality of reflection, and coherence of the portfolio as a whole.

Text Book(s):

T1. Treasure, J. (2017). *How to be Heard: Secrets for Powerful Speaking and Listening.* Mango Publishing.
T2. Beebe, S. A., Beebe, S. J., & Ivy, D. K. (2019). *Communication: Principles for a Lifetime* (7th ed.). Pearson.

Reference Book(s):

R1. Goleman, D. (1995). *Emotional Intelligence: Why It Can Matter More Than IQ.* Bantam Books.

R2. Patterson, K., Grenny, J., McMillan, R., & Switzler, A. (2011). *Crucial Conversations: Tools for Talking When Stakes Are High* (2nd ed.). McGraw-Hill.

R3. Cuddy, A. (2015). *Presence: Bringing Your Boldest Self to Your Biggest Challenges.* Little, Brown and Company.

R4. Fisher, R., Ury, W., & Patton, B. (2011). *Getting to Yes: Negotiating Agreement Without Giving In* (3rd ed.). Penguin Books.

R5. Stone, D., Patton, B., & Heen, S. (2010). *Difficult Conversations: How to Discuss What Matters Most* (2nd ed.). Penguin Books.

Web Sources:

- ted.com/topics/communication
- ted.com/topics/leadership
- hbr.org (Harvard Business Review — communication and leadership articles)
- psychologytoday.com/us/basics/emotional-intelligence

• learnprompting.org • unesco.org/en/artificial-intelligence/ethics • yoodli.ai (AI speech coaching) • themuse.com (professional communication and career resources) • mindtools.com (communication skills and workplace tools)
Topics relevant to "SKILL DEVELOPMENT": Vocabulary building and register awareness; precise and concise language use; explaining technical terms to non-specialist audiences; active listening and information processing; converting spoken inputs into structured written responses; writing action notes and follow-up communications; professional presence and vocal authority; interview communication and the STAR framework; idea pitching and persuasive speaking; negotiation and principled disagreement; chairing and facilitating discussions; managing communication under pressure; communication strategy and audience mapping; emotional intelligence in professional contexts; adapting communication style across personalities and power gaps; giving and receiving developmental feedback; navigating difficult conversations; repairing communication breakdowns; AI as a strategic communication tool; ethics of AI in professional communication.

Catalogue prepared by	Dr Ajith K and Dr Shahanas Punnilath Shanavas
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

Course Code: APT4004	Course Title: Aptitude Training-Intermediate Type of Course: Practical Only Course	L- T - P- C	0	0	2	0
Version No.	1.0					
Course Pre-requisites	Students should have the basic concepts of Quantitative aptitude along with its applications in real life problems.					
Anti-requisites	NIL					
Course Description	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.					
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 Out Comes	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.		
Course Content:			
Module 1	Quantitative Ability 1	Assignment	16 Hours
Topics: Number System, Percentage, Ratio and Proportion, Average, Mixture and Allegation, Time and Work, Profit and Loss			
Module 2	Quantitative Ability 2	Assignment	14 Hours
Topics: Time Speed and Distance, Boats and Streams, Simple Interest, Compound Interest, Probability, Permutation and Combination			
Targeted Application & Tools that can be used: Application area: Placement activities and Competitive examinations. Tools: LMS			
Continuous Evaluation:			
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

<table>
<tr><td>Course Code:
APT4002</td><td colspan="3">Course Title: Introduction to Aptitude

(Audited)</td><td>L- P- C</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 know the basic Mathematics & aptitude along with understanding of English</td></tr>
<tr><td>Anti-requisites</td><td colspan="7">Nil</td></tr>
<tr><td>Course Description</td><td colspan="7">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.</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 Outcomes</td><td colspan="7">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</td></tr>
<tr><td>Course Content:</td><td colspan="7"></td></tr>
<tr><td>Module 1</td><td>Quantitative Ability</td><td>Assignment</td><td colspan="2">Bloom’s Level : Application</td><td colspan="3">12 Hours</td></tr>
<tr><td colspan="8">Topics:
Introduction to Aptitude, working of Tables, Squares, Cubes</td></tr>
<tr><td>Module 2</td><td>Logical Reasoning</td><td>Assignment</td><td colspan="2">Bloom’s Level : Application</td><td colspan="3">18 Hours</td></tr>
<tr><td colspan="8">Topics:
Linear & Circular Arrangement Puzzle, Coding & Decoding, Blood Relations, Directions, Ordering and Ranking, Clocks and Calendars, Number Series, Wrong number series, Visual Reasoning</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">Text Book
1. Quantitative Aptitude by R S Aggarwal
2. Verbal & Non-Verbal Reasoning by R S Aggarwal</td></tr>
<tr><td colspan="8">References
1. www.indiabix.com
2. www.youtube.com/c/TheAptitudeGuy/videos</td></tr>
</table>

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	

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	