KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

"JNANA GANGA" UDYAMBAG, BELAGAVI-590008,
KARNATAKA, INDIA.
Approved by AICTE and UGC
Permanently Affiliated and Autonomous Institution
Under
Visvesvaraya Technological University, Belagavi
www.git.edu

ESTD. 1939

ESTD. 1979

5th to8th Semester B.E.

Electronics and Communication Engineering

Scheme and Syllabus (2022 Scheme)

INSTITUTION VISION
Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION
To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem-solving ability with an analytical and innovative mindset.

QUALITY POLICY
• Imparting value-added technical education with state-of-the-art technology in a congenial, disciplined and a research-oriented environment. • Fostering cultural, ethical, moral and social values in the human resources of the institution. • Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

DEPARTMENT VISION
The Electronics & Communication Engineering department shall impart quality technical education and entrepreneurship skills to develop creative individuals to face changing global scenario.

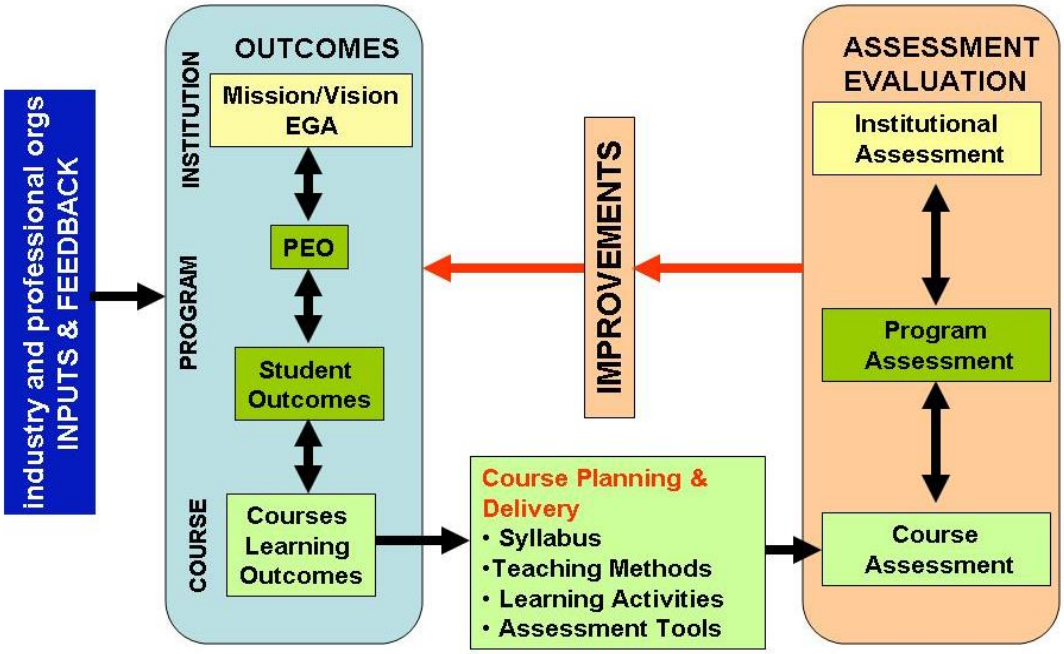
DEPARTMENT MISSION
To augment the national talent pool, with Electronics and Communication Engineers having all-encompassing technical knowledge, principled practices and nationalistic outlook.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)	
1.	The graduates will acquire core competence in basic science and Electronics and Communication Engineering fundamentals necessary to formulate, analyze, and solve engineering problems and to pursue advanced study or research.
2.	The graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth and self-confidence to adapt to rapid and major changes.
3.	The graduates will maintain high professionalism and ethical standards, effective oral and written communication skills, work as part of teams on multidisciplinary projects under diverse professional environments, and relate engineering issues to the society, global economy and to emerging technologies.

PROGRAM OUTCOMES (POs)	
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6.	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7.	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9.	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
10.	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11.	**Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of basic Electronics and Communication systems.
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.

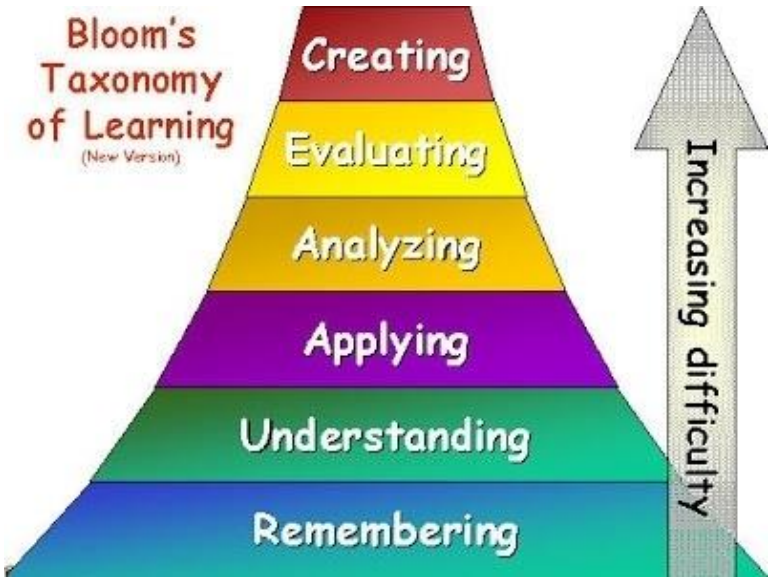
OUTCOME BASED EDUCATION (OBE)



BLOOM'S TAXONOMY OF LEARNING OBJECTIVES

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 by Benjamin Bloom and modified during the 1990's by a new group of cognitive psychologists, led by Lorin Anderson (a former student of Bloom's) to make it relevant to the 21stcentury. The **revised taxonomy** given below emphasizes what a learner "Can Do".

Lower order thinking skills (LOTS)		
L1	Remembering	Retrieve relevant knowledge from memory.
L2	Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.
L3	Applying	Carry out or use a procedure in a given situation–using learned knowledge.
Higher order thinking skills (HOTS)		
L4	Analyzing	Breakdown knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.
L5	Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.
L6	Creating	Combining or reorganizing elements to form a coherent or functional whole or into a new pattern, structure or idea.



KLS Gogte Institute of Technology
3rd to 8th sem B.E.
Scheme of Teaching and Examination- 2022
Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2023-24)

Total credits for B.E. Program: 160

Credit definition:

Offline Courses	Online Courses
• 1-hour Lecture **(L)** per week = 1 Credit • 2 hours Tutorial **(T)** per week = 1 Credit, • 2 hours Practical /Drawing **(P)** per week = 1 Credit	04 weeks =1 Credit 08 weeks = 2 Credit 12 weeks = 3 Credit

Semester wise distribution of credits for B.E program

Year	Semester	Credits	Total/Year	Cumulative Credits
1st	I	20	40	40
	II	20		
2nd	III	20	40	80
	IV	20		
3rd	V	22	40	120
	VI	18		
4th	VII	24	40	160
	VIII	16		
Total			160	

Curriculum frame work:

Structure of Undergraduate Engineering program

S.No.	Category of courses	VTU Breakup of credits	KLSGIT Breakup of credits
1	Humanities and Social Sciences including Management courses (English, Kannada, Indian Constitution, Environmental Sciences, Health and Management)	9	10
2	Basic Science courses	22	22
3	Engineering Science courses including ETC, PLC & Drawing	24	24
4	Professional Core Courses	54	54
5	Professional Elective courses relevant to chosen specialization/branch	12	12
6	Open subjects – Electives from other technical, emerging, arts, commerce	9	9
7	Mini, Project, Major Project work and Seminar	10	9
8	Summer Internship and Research /Industrial Internship	10	10
9	Ability Enhancement Courses, including Research Methodology, NCC/NSS/ Sports/Ex- Curricular, Online Certification Course	8	8
10	Universal Human Values	2	2
	TOTAL	**160**	**160**

L-T-P Model for Courses

	Contact Hours				Credits	
S.No.	**L-T-P**	**Lecture**	**Tutorial**	**Practical**	**L-T-P**	**Total**
1	3 - 0 - 0	3	0	0	3 - 0 - 0	3
2	3 - 2 - 0	3	2	0	3 - 1 - 0	4
3	3 - 0 - 2	3	0	2	3 - 0 - 1	4
4	2 - 0 - 2	2	0	2	2 - 0 - 1	3
	1 - 0 - 4	1	0	4	1 - 0 - 2	3

Theory courses having the corresponding lab are converted to integrated type course. Also, the electives (if possible) can also be made integrated type.

Integrated courses (Professional Core/Electives): Integrated courses will have **Theory Syllabus with Practical Syllabus of the same course**. In such a course there could be **no Semester End Examination (SEE) for the practical syllabus** of the course, however, Continuous Internal Evaluation (CIE) will be conducted for the practical topics. SEE can include questions from practical topics.

SDA-Skill Development Activities, TD/PSB- Teaching Department / Paper Setting Board, ASC-Applied Science Course, ESC- Engineering Science Courses, ETC- Emerging Technology Course, AEC- Ability Enhancement Course, HSMS-Humanity and Social Science and Management Course, SDC- Skill Development Course.

5th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	HSMS	22EC51	Management for Electronics Engineers	E & C	3	0	0	03	3	100	100	200
2	PCC	22EC52	CMOS VLSI Circuit Design	E & C	3	0	0	03	3	100	100	200
3	IPCC	22EC53	Digital Signal Processing	E & C	3	0	2	05	4	100	100	200
4	PEC	22EC54x	Professional Elective Course	E & C	3	0	0	03	3	100	100	200
5	PROJ	22EC55	Mini Project	E & C	0	0	4	04	2	100	-	100
6	AEC	22AECEC56	Research Methodology and IPR	E & C	2	0	0	02	2	100	100	200
7	AEC	22AECEC57	Employability Skills -1	Bizotic	1	0	0	01	1	100	-	100
8	MC	22EC58A	Environmental Studies	Chem/CV	2	0	0	02	2	100	100	200
9	MC	22EC58B1	National Service Scheme (NSS)/	NSS coordinator	0	0	2	02	0	100	-	100
		22EC58B2	Physical Education (PE) (Sports and Athletics) and Yoga/	Physical Education dept & Yoga instructor								
		22EC58B3	Clubs- Social, Cultural & Academic	Coordinators								
10	PCCL	22ECL59	CMOS VLSI Lab	E & C	0	0	4	04	2	50	50	100
Total									**22**	**950**	**650**	**1600**

Professional Elective Course 22EC54x			
22EC54A	Automotive Systems	22EC54F	Multimedia Communication
22EC54B	Operating System	22EC54G	Cryptography and Network Security
22EC54C	Power Converters	22EC54H	Requirements Engineering
22EC54D	Embedded System Design	22EC54I	Data Analysis and Visualization with Python
22EC54E	Digital Image Processing	22EC54J	Automotive Cybersecurity*

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective course

*Harman offered.

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga/Clubs: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga(YOG) and Clubs with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Club activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands-on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the **project publication/technical paper**, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the **project publication/technical paper**, project presentation skills, and question-answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

6th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	PCC	22EC61	ARM Microcontroller	E & C	3	0	0	03	3	100	100	200
2	IPCC	22EC62	Digital Communication	E & C	3	0	2	05	4	100	100	200
3	PEC	22EC63x	Professional Elective Course	E & C	3	0	0	03	3	100	100	200
4	OEC	22EC64x	Open Elective Course	E & C	3	0	0	03	3	100	100	200
5	PROJ	22EC65	Major Project Phase I	E & C	0	0	4	04	2	100	--	100
6	AEC/SDC	22AECEC66	Employability Skills -2	Bizotic	1	0	0	01	1	100	-	100
7	MC	22EC671	National Service Scheme (NSS)/	NSS coordinator	0	0	2	02	0	100	--	100
		22EC672	Physical Education (PE) (Sports and Athletics) and Yoga/	Physical Education dept & Yoga instructor								
		22EC673	Clubs- Social, Cultural & Academic	Coordinators								
8	PCCL	22ECL68	ARM Microcontroller Lab	E & C	0	0	2	02	1	50	50	100
9	PCCL	22ECL69	Linear Integrated Circuits Design Lab	E & C	0	0	2	02	1	50	50	100
Total									**18**	**800**	**500**	**1300**

Professional Elective Course22EC63x			
22EC63A	Modern Electric, Hybrid Electric and Fuel Cell Based Vehicles	22EC63F	Adaptive Digital Signal Processing
22EC63B	Low Power Architecture	22EC63G	Internet of Things and Cyber Physical Systems
22EC63C	Digital System Design with FPGA	22EC63H	Computational Intelligence and Applications
22EC63D	Robotics & Automation	22EC63I	DBMS
22EC63E	Bio Medical Image Understanding and Analysis	22EC63J	Digital Forensics

Open Elective Course22EC64x			
22EC641	Human Computer Interaction	22EC645	Modern Vehicular Technology
22EC642	Embedded Systems with Arduino	22EC646	Cyber Shield: Hands-On Security Practices*
22EC643	Digital Image Processing	22EC647	Programming for Industry using Linux#
22EC644	Requirements Engineering		

***Course contents from Microsoft**

 # Industry offered(open to all)

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga/Clubs: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga(YOG) and Clubs with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Club activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

7th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	IPCC	22EC71	Communication Networks	E & C	3	0	2	05	4	100	100	200
2	IPCC	22EC72	Microwave and Antenna Engineering	E & C	3	0	2	05	4	100	100	200
3	PCC	22EC73	Wireless Communication	E & C	3	0	0	03	3	100	100	200
4	PEC	22EC74x	Professional Elective Course	E & C	3	0	0	03	3	100	100	200
5	OEC	22EC75x	Open Elective Course	E & C	3	0	0	03	3	100	100	200
6	PROJ	22EC76	Major Project Phase-II	E & C	0	0	10	10	5	100	100	200
7	AEC	22AECEC77	Indian Knowledge System		1	0	0	01	1	100	-	100
8	PCCL	22ECL78	Advanced Wireless Communication Lab	E & C	0	0	2	02	1	50	50	100
Total									**24**	**750**	**650**	**1400**

Professional Elective Course 22EC74x			
22EC74A	Advanced VLSI Design	22EC74F	Natural Language Processing
22EC74B	RF and Microwave Integrated Circuits	22EC74G	Human Computer Interaction
22EC74C	Biomedical System Design	~~22EC74H~~	~~Cyber Security – A Practical Approach~~
22EC74D	Satellite Communication Techniques	22EC74I	Multirate Digital Signal Processing
22EC74E	Vehicular Networks		

Open Elective Course 22EC75x			
22EC751	Digital Forensics	22EC754	Computational Intelligence
22EC752	Bio Medical Image Understanding and Analysis	22EC755	Fundamentals of Robotics
22EC753	Artificial Neural Networks		

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK: The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the COE. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

8th Semester					Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	PEC	22EC81x	Professional Elective (Online Courses)	TD-PSB	3	0	0	03	3	100	-	100
2	OEC	22EC82x	Open Elective (Online Courses)	TD: PSB	3	0	0	03	3	100	-	100
3	INT	22EC83	Internship (Industry/Research) (14 - 20 weeks)	TD: PSB	0	0	20	20	10	100	100	200
Total									**16**	**300**	**100**	**400**

Professional Elective Course (Online courses) 22EC81x Subject to availability on NPTEL and list will be prepared accordingly			
22EC81A	**Analog VLSI Design**	22EC81H	**Simulation of Communication Systems using MATLAB**
22EC81B	**VLSI Design Flow: RTL to GDS**	22EC81I	**Principles and Techniques of Modern Radar Systems**
22EC81C	**Digital VLSI Testing**	22EC81J	**Real-Time Digital Signal Processing**
22EC81D	**Microelectronics: Devices to Circuits**	22EC81K	**Applied Linear Algebra for Signal Processing, Data Analytics and Machine Learning**
22EC81E	**Semiconductor Devices and Circuits**	22EC81L	**Electrical Measurement and Electronic Instruments**
22EC81F	**C-Based VLSI Design**		
22EC81G	**Fiber Optic Communication Technology**		
Open Elective Courses (Online Courses 22EC82x Subject to availability on NPTEL and list will be prepared accordingly			
22EC82A	**Computer Architecture**	22EC82K	**Software Testing**
22EC82B	**Advanced Distributed Systems**	22EC82L	**Pattern Recognition and Application**
22EC82C	**Cloud Computing**	22EC82M	**Computer Vision**

22EC82D	**Programming in Modern C++**	22EC82N	**Machine Learning and Deep Learning - Fundamentals and Applications**
22EC82E	**Getting Started with Competitive Programming**	22EC82O	**Deep Learning**
22EC82F	**The Joy of Computing using Python**	22EC82P	**Reinforcement Learning**
22EC82G	**Data Structure and Algorithms using Java**	22EC82Q	**Responsible & Safe AI Systems**
22EC82H	**Introduction to Internet of Things**	22EC82R	**Design of Mechatronic Systems**
22EC82I	**Introduction to Industry 4.0 and Industrial Internet of Things**	22EC82S	**Industrial Robotics: Theories for Implementation**
22EC82J	**Software Engineering**		

L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship

Note: VII and VIII semesters of IV years of the program

Swapping Facility

- Institution can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ industry internships/Rural Internship** after the VI semester**.**
- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship. Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment. The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **College shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the college web portal.

Management for Electronics Engineers

Course Code	22EC51	**Course type**	HSMS	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand Characteristics and roles of management in an Electronics Industry.
2.	Understand the need of entrepreneur & characteristics of Entrepreneurship
3.	Apply to verify the opportunities of MSME's through various Central and State Institutional Supports.
4.	Analyze the need of Project report for Business Proposals.

Unit – I	**Contact Hours = 8 Hours**
Management: Introduction, nature and characteristics of Management, Scope and Functional areas of management, Management as a science, art of profession **Planning:** Nature, importance and purpose of planning process, Types of plans, Decision making, Importance of planning, steps in planning. **Organizing:** Nature and purpose of organization, Principles of organization, Types of organization (based on departments, based on commands), Span of control, MBO **Course Activity: Identify the roles various managers in an electronic core organization.**	

Unit – II	**Contact Hours = 8 Hours**
Staffing, Directing & Controlling: Nature and importance of staffing, Process of Selection & Recruitment, Training Methods **Directing:** Meaning and nature of directing, Leadership styles, Motivation Theories (McGregor's Theory of X and Y, Maslow's Hierarchy of needs theory, Herzberg's Motivation-Hygiene Theory), Communication- Meaning and importance **Controlling:** Meaning and steps in controlling, Essentials of a sound control system, Methods of establishing control. **Course Activity: Identify the roles of HR Department in different department of the electronics industry.**	

Unit – III	**Contact Hours = 8 Hours**
Entrepreneur: Meaning of entrepreneur: Evolution of the concept: Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Evolution of Entrepreneurship, The Entrepreneurial Culture and Stages in entrepreneurial process. **Creativity and Innovation**: Creativity, Source of New Idea, Ideas into Opportunities, Creative Problem Solving: Heuristics, Brainstorming, Synectics, Significance of Intellectual Property Rights. **Course Activity**: **Identify the innovative start-ups recently launched based on Electronic product or service.**	

Unit – IV	Contact Hours = 8 Hours
Micro, Small and Medium Enterprises [MSMEs] and Institutional Support: Business environment in India**,** Role of MSMEs**,** Government policies towards MSMEs, Impact of Liberalization, Privatization and Globalization on MSMEs. **Institutional support**: NSIC, TECKSOK, KIADB, KSSIDC, SIDBI; KSFC; KDEM **Course Activity: Identify the nearby MSMEs funded through various institutional support**	

Unit – V	Contact Hours = 8 Hours
Preparation of Project report and Business Plan: Meaning of Project, Project Identification, Project Selection, Project Report, Need and Significance of Report, Contents. **Business Plan**: Need of business plan, anatomy of business plan, executive summary, business description, Business environment analysis, background information. **Venture Capital:** Meaning, Need, Types and Venture capital in India **Course Activity**: **Identify the roles of Angel Investors to support financial needs of start-ups and visit to incubation center.**	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Henry Koontz, "Essentials of Management", McGraw Hill, 10th Edition 2017 onwards
2.	Poornima.M.Charantimath, "Entrepreneurship Development", Pearson Education, 2014 Edition onwards
	Reference Books:
1.	P.C.Tripathi, P.N.Reddy "Principles of Management" — Tata McGraw Hill.
	Dr.M.M.Munshi,Prakash Pinto and Ramesh Katri "Entrepreneurial Development" Himalaya Publishing House, 2016.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/110107150 - (Principles of Management, IIT Roorkee)

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the Functions of management, Characteristics of Management, and Purpose of Planning.	Un	8,9,10,11,12	2
2.	**Understand** the need and role of entrepreneur in the development of the industry.	Un	7,8,9,10,11,12	2,3
3.	**Apply** to verify the opportunities of MSME's through various Central and State Institutional Supports and for the Start Up.	Ap	6,7,8,9,10,11,12	2,3
4.	**Analyze** a business plan and its report to the support organizations.	An	6,7,8,9,10,11,12	3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1								✓	✓	✓	✓	✓		✓	
2							✓	✓	✓	✓	✓	✓		✓	✓
3						✓	✓	✓	✓	✓	✓	✓		✓	✓

4						✓	✓	✓	✓	✓	✓				✓
Use tick mark(✓)															

CMOS VLSI Circuit Design

Course Code	22EC52	Course type	PCC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the fundamentals characteristics and parameters of MOSFET based circuits.
2.	To analyze MOSFET based circuits on the basis of given data.
3.	To design MOSFET based circuits for specific requirements.

Pre-requisites: Electrical Circuits, Analog Electronics, Digital Electronics

Unit – I	Contact Hours = 8 Hours
MOSFETs in Amplifier Design: Device Structure and Physical Operation, Current–Voltage Characteristics, The i_D–v_{DS} Characteristics, The i_D–v_{GS} Characteristic, Finite Output Resistance in Saturation, Applying the MOSFET in Amplifier Design, The Voltage Transfer Characteristic (VTC), Biasing the MOSFET to Obtain Linear Amplification, The Small-Signal Voltage Gain, Determining the VTC by Graphical Analysis.	

Unit – II	Contact Hours = 8 Hours
Small-Signal Operation and Models: The DC Bias Point, The Signal Current in the Drain Terminal, The Voltage Gain, Separating the DC Analysis and the Signal Analysis, Small-Signal Equivalent-Circuit Models, The Transconductance gm, Basic MOSFET Amplifier Configurations, The Common-Source (CS) Amplifier, The Common-Gate (CG) Amplifier, The Common-Drain (CD) Amplifier, Biasing in MOS Amplifier Circuits	

Unit – III	Contact Hours = 8 Hours
Characterization & performance Estimation: Definitions, RC delay model, effective resistance, gate and diffusion capacitance, equivalent RC circuits; linear delay model: logical effort, parasitic delay; Logical Effort of path: Delay in multistage networks. **Case Study:** Design of gates for a specified delay, Elmore delay model analysis for basic gates, and simple circuits.	

Unit – IV	Contact Hours = 8 Hours
CMOS Fabrication and Layout: CMOS fabrication and layout, layout design rules, gate layouts, stick diagrams, sheet resistance and area capacitance concepts, delay unit. **(Conceptual overview with numerical problem solving for analysis)**. **Case Study:** Stick and layout diagrams for basic gates/SOP/POS equations; RC delay calculations from layout.	

Unit – V	Contact Hours = 8 Hours

Combinational Circuit Design: Introduction, circuit families: pseudo nMOS, Cascode Voltage Switch Logic (**CVSL**), dynamic circuits, domino logic, pass transistor circuits, Bi-CMOS circuits. **Sequential MOS Logic Circuits**: Introduction, behavior of bi-stable elements, SR latch circuits, clocked latch and flip flop circuits, CMOS D-latch and edge triggered flip-flop. **Case Study:** Designing of Logical Gates/Circuits with Different CMOS Logic Structures.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Neil Weste, and David Harris, "CMOS VLSI Design, A Circuits and System Perspective", 4 th Edition; Pearson Education, India.
2.	Douglas Pucknell, and Kamran Eshragian, "Basic VLSI Design", PHI Publications India Pvt. Ltd.
3.	Sedra Smith, "Microelectronic Circuits", 6th edition, Oxford University Press.
	Reference Books:
1.	Wayne Wolfe, "Modern VLSI Design, System-On-Chip Design", Prentice Hall, 2002 Onwards
	E-resourses (NPTEL/SWAYAM)
1.	Prof. Sudeb Dasgupta, IIT Roorkee, "CMOS Digital VLSI Design", https://onlinecourses.nptel.ac.in/noc24_ee29/preview
2.	Prof. Janakiraman, IIT Madras, "Digital IC Design", https://onlinecourses.nptel.ac.in/noc24_ee43/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Understand the operation and characteristics of MOSFET to study analog and digital circuits.	Un	1, 2	1
2.	Apply the MOSFET models to design and characterization of analog amplifier/digital CMOS circuits.	Ap	1,2,3,4,5,12	1

3.	Analyze the CMOS circuits parameters for optimizing the performance.	An	1,2,3,4,5,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓							✓	✓		
2	✓	✓			✓							✓	✓		
3	✓	✓			✓							✓	✓		
4															
Use tick mark(✓)															

Digital Signal Processing

Course Code	**22EC53**	**Course type**	**IPCC**	**Credits L-T-P**	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	05 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the fundamental concepts of digital signal processing, including sampling, reconstruction, and frequency domain analysis using the Discrete Fourier Transform (DFT).
2.	To apply various DSP algorithms and techniques, such as Fast Fourier Transform (FFT) and digital filter design methods, to process and manipulate discrete-time signals.
3.	To analyze the performance and efficient implementation of digital filters and signal processing algorithms, assessing their effectiveness and efficiency in different signal processing applications.

Required Knowledge of: Engineering Mathematics, Signals and Systems

Unit – I	**Contact Hours = 8 Hours**
Discrete-Time Processing of Continuous-Time Signals, Typical DSP System (Block Diagram), simulation of analog integrator, Ideal bandlimited differentiator. Discrete Fourier Transform (DFT): Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, DFT and inverse DFT (IDFT). DFT as a Linear Transformation. Application of Properties of the DFT.	

Unit – II	**Contact Hours = 8 Hours**
Efficient Computation of the DFT: FFT Algorithms, Direct Computation of the DFT, Divide-and-Conquer Approach to Computation of the DFT. Radix-2 FFT Algorithms: Decimation in Time FFT (DIT FFT), Decimation in Frequency FFT (DIF FFT) Applications of FFT Algorithms: Efficient Computation of the DFT of Two Real Sequences, Efficient Computation of the DFT of a 2*N*-Point Real Sequence, numericals	

Unit – III	**Contact Hours = 8 Hours**
Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, Filtering of Long Data Sequences: overlap save and overlap add method. Design of Digital Filters: Characteristics of Practical Frequency-Selective Filters Design of Finite Impulse Response (FIR) Filters: Symmetric and Antisymmetric FIR Filters, Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method.	

Unit – IV	Contact Hours = 8 Hours
IIR Filters: Simple filter design by Pole-Zero placement Design of IIR Filters from Analog Filters: IIR Filter Design by the Bilinear Transformation Characteristics of Commonly Used Analog Filters: Butterworth filters, Chebyshev filters (Type – I) Frequency Transformations: Frequency Transformations in the Analog Domain, Frequency Transformations in the Digital Domain. Introduction to Optimum Filters: Linear Prediction (Forward and Backward), Wiener Filters and Kalman Filters (mention application)	

Unit – V	Contact Hours = 8 Hours
Digital Filter Realizations: Structures for FIR Systems: direct form, cascade and lattice structures. Structures for IIR Systems: direct form, signal flow graphs and transposed structures, cascade, parallel, lattice and lattice ladder structures. Introduction to Multirate Digital Signal Processing: Decimation by factor D, Interpolation by factor I, Sample rate conversion by a rational factor. Adaptive Filters, Applications of Adaptive filters.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	1. Spectral analysis of discrete time (DT) signal (sampled speech) using DFT. 2. Linear convolution and circular using DFT. 3. Study of mathematical operations (addition, scaling, delay etc.) on DT signals (sampled speech) and its consequences in the frequency domain.
2	3	4. Implementation of DIT FFT and DIT IFFT algorithm. 5. Implementation of DIF FFT and DIF IFFT algorithm. 6. Efficient Computation of: DFT of Two Real Sequences and DFT of a 2*N*-Point Real Sequence.
3,5	2	7. Design and realization (using DF-II transposed structure) of Digital Butterworth low pass filter (LPF) and high pass filter (HPF). 8. Design and realization (using DF-II transposed structure) of Digital Chebyshev Type – I low pass filter (LPF) and high pass filter (HPF).
4,5	2	9. Design and realization (using DF structure) of FIR LPF. 10. Design and realization (using DF structure) of FIR HPF.

Books	
	Text Books:
1.	J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Publications, 2017 onwards. (For theory)
2.	E. Ifeachor and B. W. Jervis, Digital Signal Processing: A Practical Approach, 2002 onwards. (for lab)
	Reference Books:
1.	A. V. Oppenheim, R. W. Schafer and J. R. Buck, Discrete Time Signal Processing, Pearson Publications, 2021 onwards.
2.	Li Tan, Digital Signal Processing: Fundamentals and Applications, Elsevier, 2008 onwards.
3.	Sanjit K. Mitra, Digital Signal Processing: A Computer Based Approach, Tata McGraw Hills, 2013 onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Digital Signal Processing, by Prof. S. C. Dutta Roy, IIT Delhi, link: https://nptel.ac.in/courses/117102060
2.	Digital Signal Processing, by Prof. T. K. Basu, IIT Kharagpur, link: https://archive.nptel.ac.in/courses/108/105/108105055/#
3.	Digital Signal Processing and its Applications, by Prof. V. M. Gadre, IIT Bombay, link: https://archive.nptel.ac.in/courses/108/101/108101174/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels :

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Explain the sampling, reconstruction and discrete time processing of continuous-time signals and describe the importance of the Discrete Fourier Transform (DFT) in the frequency-domain analysis.	Un	1,2,3,5,10	1,2
2.	Implement Fast Fourier Transform (FFT) algorithms for efficient DFT computation and design digital filters (FIR and IIR) to process discrete-time signals for various DSP applications.	Ap	1,2,3,5,10	1,2

3.	Analyze the structure and performance of digital filters and signal processing algorithms, evaluating their impact on the frequency response and overall system performance in different scenarios.	An	1,2,3,5,10	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)		LAB (40 marks)		Total
IA test 1	IA test 2	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 15 marks 5. Viva voce: 10 marks				
Eligibility for SEE: 1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE** 2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.** 3. Lab test is COMPULSORY 4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.** 5. Not eligible in any one of the two components will make the student **Not Eligible** for SEE				

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping (planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓					✓			✓	✓	
2	✓	✓	✓		✓					✓			✓	✓	
3	✓	✓	✓		✓					✓			✓	✓	
Use tick mark(✓)															

Research Methodology and IPR

Course Code	22AECEC56	Course type	AEC	Credits L-T-P	2-0-0
Hours/week: L-T-P	2-0-0			Total credits	2
Total Contact Hours	L = 30 Hrs; Total = 30 Hrs			CIE Marks	100
Flipped Classes content	05 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the basic concepts of research and its methodologies
2.	Identify and select the appropriate research.
3.	Understand the basic concepts & types of hypothesis.
4.	Create the awareness about Intellectual Property Rights for the protection of inventions.

Required Knowledge of : --

Unit – I	Contact Hours = 5 Hours

Research Methodology: Introduction

Meaning, Objectives, types, Research Approaches. Significance of Research, Research Methods versus Methodology, Research and scientific method, research Process, Criteria of good research, Problems encountered by researchers.

Unit – II	Contact Hours = 6 Hours

Research Problem: Defining a research problem, Selecting a research problem, necessity and techniques involved in defining the research problem.

Data Collection Methods: Collection of Primary Data, Observation Method, Interview Method, Questionnaires, Schedules, Collection of Secondary Data, Case study method.

Unit – III	Contact Hours = 9 Hours

Processing and Analysis of Data

Processing operations, Elements/ types of analysis, Statistics in research- measures of central tendency or statistical averages, measures of dispersion, measures of asymmetry (skewness), measures of relationship.

Testing of hypothesis 1

Definition, basic concepts, procedure, flow diagram, measuring the power of hypothesis tests, tests of hypothesis.

Chi-square test

Chi-square as a test for comparing variance, steps involved in applying chi-square test.

Unit – IV	Contact Hours = 5 Hours
Intellectual Property Rights – IPR- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures. Research ethics, Plagiarism, Prior art search.	

Unit – V	Contact Hours = 5 Hours
Interpretation and Report Writing: Meaning of interpretation, Why interpretation, Technique of interpretation, Precaution in interpretation, Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Mechanics of writing research report.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	01	01	01	01	01

Unit No.	Self-Study Topics [Mention if applicable else NIL]
1	Significance of Research Methodology.
2	Limitations of test of hypothesis.
3	Other measures-Index numbers, Time series analysis.

Books	
	Text Books:
1.	C R. Kothari, **"Research Methodology"**, New Age International Publishers, 2nd edition, 2007.
2.	Dr. B.L. Wadhera, **"Intellectual Property Rights"**, Universal Law Publishing Co. Ltd.. 2002
	Reference Books:
1.	Panneer Selvam, **"Research Methodology"**, PHI Learning Pvt. Ltd., 2007.
	E-resources (NPTEL/SWAYAM.. Any Other)-
1.	https://onlinecourses.swayam2.ac.in/cec20_ge37

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Assignments (OA)
3.	Flipped Classes	3.	Case studies
4.		4.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Identify and select an appropriate methodology for research.	**Un**	**1,2,9,10**	**1**
2.	Analyze and interpret data collected	**Ap**	**1,2,9,10**	**1**
3.	Analyze the significance of hypothesis testing	**An**	**1,2,9,10**	**1**
4.	Discuss the significance of Intellectual Property Rights & report writing	**Ap**	**1,2,3,9,10,12**	**1,2,3**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**		
CO/ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1	✓	✓							✓	✓			✓		
2	✓	✓							✓	✓			✓		
3	✓	✓							✓	✓			✓		
4	✓	✓	✓						✓	✓		✓	✓	✓	✓

Employability Skills I

Course Code	22AECEC57	Course type	AEC	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 0 Hrs Total = 30 Hrs			CIE Marks	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Pre-requisites :

Unit – I	Contact Hours = 6 Hours
***Quantitative Aptitude*:** Number System (2 Hours), HCF, LCM and Decimal Fractions (1 Hour), Simplification (1 Hour) ***Logical Reasoning*:** Blood Relations (1 Hour), Direction Sense Test (1 Hour)	

Unit – II	Contact Hours = 6 Hours
Quantitative Aptitude*:** Percentages (2 Hours), Profit, Loss and Discounts (2 Hours) ***Verbal Ability: Change of Speech and Voice (2 Hours)	

Unit – III	Contact Hours = 6 Hours
Quantitative Aptitude*:** Simple and Compound Interest (2 Hours) ***Logical Reasoning*:** Number and Letter Series (2 Hours) ***Verbal Ability: Sentence Correction (2 Hours)	

Unit – IV	Contact Hours = 6 Hours
***Quantitative Aptitude*:** Averages (2 Hours) ***Logical Reasoning*:** Coding and Decoding (1 Hour), Analogy (1 Hour) ***Soft Skills*:** Body Language (1 Hour), Grooming and Etiquette (1 Hour)	

Unit – V	Contact Hours = 6 Hours
Quantitative Aptitude: Alligations and Mixtures (2 Hours) ***Verbal Ability*:** Sentence Completion (2 Hours) ***Soft Skills*:** Group Discussion and Mock GDs (2 Hours)	

Books	
	Text Books:

	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	The Aptitude Triad , BIZOTIC
2.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.
3.	How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
4.	How to prepare for Verbal Ability and Reading Comprehension for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
5.	How to prepare for Data Interpretation for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 5th Edition, 2018.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes
		3.	Assignments
		4.	Seminar

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10, 12	
2.	Perform confidently during the GD and Interview process	L2	10, 12	
3.	Develop behaviors that are appropriate for a professional	L2	10, 12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two Assignments	Total Marks
Marks	30+30 = 60	20	10+10 =20	100

- Writing 2 IA tests are compulsory

-Student should score minimum 40% of 100 marks to pass the course.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										✓		✓			
2										✓		✓			
3										✓		✓			

Tick mark the CO, PO and PSO mapping			

Environmental Studies

Course Code	22EC58A	Course type	HSMS	Credits L-T-P	2-0-0
Hours/week: L-T-P	2-0-0			Total credits	2
Total Contact Hours	L = 30 Hrs; Total = 30 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the scope of Environmental Engineering.
2.	Identify the Environmental impact due to Human activities.
3.	Identify the renewable and non-renewable sources of energy.
4.	To understand the concept of Disaster Management.
5.	Identify the various Legal aspects in Environmental Protection.

Required Knowledge of : Nil

Unit – I	Contact Hours = 6 Hours
Definition of Environment, Ecology and Ecosystem, Structure and functions of ecosystem, balanced ecosystem, Introduction to Environmental Impact Assessment Natural Resources: Material Cycles – Oxygen, Carbon, Nitrogen and Hydrological cycle. Importance of water quality, Water borne diseases, Water induced diseases, Significance of Fluoride in drinking water.	

Unit – II	Contact Hours = 6 Hours
Energy – Different types of energy, Conventional and Non – Conventional sources – Advantages and Limitations of Wind Mills, Hydro Electric, Fossil fuel, Nuclear, Solar, Biomass and Biogas, Geothermal energy.	

Unit – III	Contact Hours = 6 Hours
Disasters – Natural Disasters: Meaning and nature of natural disasters, their types and effects (Floods, drought, cyclone, earthquakes, Tsunami). Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution and marine pollution.	

Unit – IV	Contact Hours = 6 Hours
Disaster Management: International strategy for disaster reduction. Concept of disaster management and national disaster management framework.	

Unit – V	Contact Hours = 6 Hours
Environmental Protection: Role of Government, Legal aspects, Initiatives by Non – Governmental Organizations (NGO), Environmental Education, Women Education. E-waste and solid waste management rules.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Unit No.	Self-Study Topics [Mention if applicable else NIL]

Books	
	Text Books:
1.	Benny Joseph, **"Environmental Studies"**, Tata McGraw – Hill Publishing Company Limited (2005).
2.	Sanjay K. Sharma, **"Environment Engineering and Disaster Management"**, USP (2011).
3.	Harsh K. Gupta, **"Disaster Management"**, Universities Press (India) Pvt. Ltd (2003).
4.	Ranjit Daniels R.J. and Jagdish Krishnaswamy, **"Environmental Studies"**, Wiley India Private Ltd., New Delhi (2009).
	Reference Books:
1.	Meenakshi P., **"Elements of Environmental Science and Engineering"**, Prentice Hall of India Private Limited, New Delhi (2006).
2.	Tyler Miller Jr. G., **"Environmental Science – Working with the Earth"**, Tenth Edition, Thomson Brooks/Cole (2004).
	E-resources (NPTEL/SWAYAM.. Any Other)-
1.	–
2.	–

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO (s)	PSO (s)
1.	Understand the importance of the Environment and different sources of energy and energy crises.	Un	**6,7**	**1**
2.	Understand various environmental disasters and its management.	Ap	**6,7**	**1**
3.	Understand the various Legislations related to Environment.	Un	**6,7**	**1**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**		
CO /PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
1						✓	✓						✓		
2						✓	✓						✓		
3						✓	✓						✓		

CMOS VLSI Circuit Design Lab

Course Code	**22ECL59**	**Course type**	**PCCL**	**Credits L-T-P**	0 - 0 - 2
Hours/week: L - T- P	0 - 0 - 4			**Total credits**	2
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 40 Hrs Total = 40 Hrs			**CIE Marks**	50
Flipped Classes content				**SEE Marks**	50

Course learning objectives	
1.	To comprehend the principles of transistor-level circuit design.
2.	To analyze circuit behavior through simulation.
3.	To optimize the designed circuit by applying standard rules and processes of CMOS Circuit design.

Required Knowledge of: Analog Electronics, Digital Electronics, CMOS VLSI Circuit Design

Lab Experiment – I	**Contact Hours = 2 Hours**
Design, analyze and validate the Common Source Amplifier for a specified current drive.	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Design, analyze and validate the Common Drain Amplifier for a specified current drive.	
Lab Experiment – 3	**Contact Hours = 2 Hours**
Design, analyze and validate the Differential Amplifier for a specified current drive.	
Lab Experiment – 4	**Contact Hours = 2 Hours**
Design, analysis and validation of the Hi/Lo/Un-skew CMOS Inverter.	
Lab Experiment – 5	**Contact Hours = 2 Hours**
Design, analysis and validation of 2 input CMOS NAND gate for the specified Rise/Fall time.	
Lab Experiment – 6	**Contact Hours = 2 Hours**
Design, analysis and validation of 2 input CMOS NOR gate for the specified Rise/Fall time.	
Lab Experiment – 7	**Contact Hours = 2 Hours**
Design, analysis and validation of 2 input CMOS AND-OR-INVERT (AOI) based XOR gate.	
Lab Experiment – 8	**Contact Hours = 2 Hours**
Design, analysis and validation of CMOS NAND Based S – R Latch.	
Lab Experiment – 9	**Contact Hours = 2 Hours**
Design, analysis and validation of D-latch using Transmission gate.	
Lab Experiment – 10	**Contact Hours = 2 Hours**
Design, analysis and validation of Dynamic CMOS Pre-Charge Evaluate logic circuit for the specified Boolean functions.	
Lab Experiment – 11	**Contact Hours = 2 Hours**
Design, analysis and validation of CMOS Filp-Flop circuit for the specified clock input.	
Lab Experiment – 12	**Contact Hours = 2 Hours**
Design, analysis and validation of CMOS RAM cell and evaluate the performance.	

Note: Execute any 10 experiments from the above list of 12 experiments.

Books	
	Text Books:
1.	Neil Weste, and David Harris, "CMOS VLSI Design, A Circuits and System Perspective", 4 th Edition; Pearson Education, India.
2.	Douglas Pucknell, and Kamran Eshragian, "Basic VLSI Design", PHI Publications India Pvt. Ltd.
3.	Sedra Smith, "Microelectronic Circuits", 6th edition, Oxford University Press.
4.	J M Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits A Design Perspective.
	E-resources (NPTEL/SWAYAM)
1.	Prof. Sudeb Dasgupta, IIT Roorkee, "CMOS Digital VLSI Design", https://onlinecourses.nptel.ac.in/noc24_ee29/preview
2.	Prof. Janakiraman, IIT Madras, "Digital IC Design", https://onlinecourses.nptel.ac.in/noc24_ee43/preview

Course delivery methods		**Assessment methods**	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
4.		4.	Lab Test
5.		5.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Verify transistor-level circuits using Cadence Virtuoso, ensuring accurate functionality and performance through detailed analysis	Ap	1,2,3,4,5,12	1
2.	Develop the capability to generate comprehensive test circuits and utilize Cadence Virtuoso for DC, AC and Transient waveform verification	An	1,2,3,4,5,12	1
3.	creating and verifying layouts for combinational and sequential circuits using Cadence Virtuoso to perform Design Rule Checks (DRC), Layout Versus Schematic (LVS) verification, and Quantitative Risk Calculation (QRC) to ensure the physical design meets all specified criteria and adheres to industry standards.	An	1,2,3,4,5,12	1

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expt	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

1. Conduction of the experiment: 15 marks + Viva voce: 5 marks
2. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks
3. Lab project/ Open ended expt: 10 marks
3. Lab Test: 15 marks

Eligibility for SEE:

1. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓											✓		
2	✓	✓	✓	✓	✓							✓	✓		
3	✓	✓	✓	✓	✓							✓	✓		
Tick mark the CO, PO and PSO mapping															

Automotive Systems

Course Code	22EC54A	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	04 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand basic concepts of Automotive System as an Electronic systems.
2.	To understand various mechanical systems, electrical and instrumentations related to an automobile.
3.	To illustrate study of vehicular chassis system, manual and auto transmission systems and related modules.
4.	To illustrate study of HVAC, vehicle safety and comfort, and vehicle diagnostics.

Pre-requisites: Basics of Mechanical Engineering, Control Systems.

Unit – I	**Contact Hours = 8 Hours**
Introduction to Automotive Electronics: Development of the automobile electrical system, The basics of Electronic Engine Controls- Motivation for Electronic Engine Control, Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine Control System, Basic Principle of Four-Stroke Engine Operation, Definition of Engine Performance Terms. Sensors and Actuators: Automotive Control System Applications of Sensors and Actuators, Temperature Sensors, Position Sensors, Coolant sensor EGO, O2, Sensor for feedback control, Automotive Engine Control Actuators.	

Unit – II	**Contact Hours = 8 Hours**
Batteries- Vehicle batteries, Lead-Acid Batteries, Maintenance charging and testing, Charging- Requirements of the charging system, principles, alternators, smart charging, advance charging systems, Starting- requirements, motors and circuits, types, advance starting system technology, Ignition- fundamentals, Electronic Ignition, distributor-less ignition system, Fuel-control- combustion, fuel injection, advance fuel control technology, Advance Engine Management technology, Digital Powertrain Control Systems.	

Unit – III	**Contact Hours = 8 Hours**
Automotive Instrumentation: Modern Automotive Instrumentation, Advantages of Computer-Based Instrumentation, Digital Display, Lighting: fundamentals, circuits, Gas discharge, LED, infra-red lighting, advance technology, Auxiliaries: windscreen, washers, signaling circuits, advance auxiliary technology, HVAC: conventional heating and ventilation, air-conditioning, other heating systems, advance temperature control technology,	

Unit – IV	**Contact Hours = 8 Hours**

Chassis Electricals: ABS, traction and stability control, active suspension, automatic transmission, advance chassis systems technology, Electronic Safety related systems: Blind Spot Detection, Automatic Collision Avoidance System, Lane Departure Monitor, Tire Pressure Monitoring System, Enhanced Vehicle Stability, Comfort and safety: seat, mirrors and sun roofs, central locking, electric windows, cruise control (4WS), in-car multimedia, advance comfort and safety systems technology, Airbags and Seatbelts.

Unit – V	**Contact Hours = 8 Hours**
Vehicle Motion Controls: introduction, cruise control (4WS), electronic suspension system, Electronic Power Steering, Diagnostics: Electronics Control System Diagnostics, Onboard Diagnostics, Model-Based Sensor Failure Detection, General Model-Based Diagnostics, Diagnostic Fault Codes, Onboard Diagnosis (OBD II), Automonous Vehicles: Automatic Parallel Parking System, Autonomous Vehicle Block Diagram.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**0**	**1**	**1**	**1**	**1**

Unit No.	**Self-Study Topics**
1	Four Stroke Engine
2	Knock sensors, Lambda Sensor, diaphragms for actuators

Books	
	Text Books:
1.	William Ribbens, Understanding Automotive Electronics – An Engineering Perspective, Butterworth-Heinemann Publication, 8th Edition.
2.	Tom Denton, Automobile Electrical and Electronics System – Automotive Technology, Vehicle Maintenance and Repairs, Routledge A Taylor & Francis Group, 4th Edition.
	Reference Books:
1.	Automotive Transmissions Fundamentals, Selection, Design and Application - Harald Naunheimer, Bernd Bertsche, Springer, 2nd Edition
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the systems applied for Electronic Engine Controls, Sensors and Actuators.	Un	1,2,3	1,2
2.	Illustrate the advance automotive electrical and electronics systems.	Un	1,2,3	1,2
3.	Apply the comfort and safety facilities for different driving conditions.	Ap	1,2,3,5,9	1,2
4.	Infer the use diagnostics for different faults.	An	1,2,5,9	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-**Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.**
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓										✓	✓	
2	✓	✓	✓										✓	✓	
3	✓	✓	✓		✓				✓				✓	✓	
4	✓	✓			✓				✓				✓	✓	
Tick mark the CO, PO and PSO mapping															

Operating Systems

Course Code	22EC54B	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	**To summarize key functions of an OS and evolution of OS**
2.	**To understand the concepts of process and various scheduling policies of OS**
3.	**To comprehend the various memory management techniques**
4.	**To learn the mass storage structure and Disk scheduling algorithms**

Pre-requisites : Basic Computer knowledge

Unit – I	**Contact Hours = 8 Hours**
Introduction: Goals of an OS, Functions of an OS: Program management, Resource management and Security & protection. **Features of computer system from OS viewpoint**: CPU, MMU, Memory Hierarchy, Input/Output, Interrupts. System calls, Computing environments and classes of OS. Structure of an OS	

Unit – II	**Contact Hours = 8 Hours**
Process Management: Process Concept: The process, Process states, Process control Block, Threads. Process Scheduling: Scheduling queues, Schedulers, Context Switch. **Uni-processor Scheduling**- Types of scheduling: Preemptive & Non-preemptive, Scheduling criteria, Scheduling algorithms: FCFS, SJF, Priority, Round Robin and Shortest Time to Go.	

Unit – III	**Contact Hours = 8 Hours**
Process Synchronization: Race condition, Critical section problem, Mutual exclusion, Semaphores, Monitors, Classic problems of Process Synchronization – The Bounded-Buffer problem, The Readers-Writers problem, The Dining Philosophers problem. **Deadlocks**: Principles of Deadlock, Resource allocation graphs, Conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance- Safe state, Banker's algorithm.	

Unit – IV	**Contact Hours = 8 Hours**
Memory Management: Memory Management requirements, Contiguous Memory Allocation- Fixed and Variable Partitioning, Memory Allocation Strategies- First Fit, Best Fit, and Worst Fit. Fragmentation-internal and External, Swapping, Segmentation, Paging. **Virtual Memory**: Introduction, Management of Virtual Memory, Demand Paging, Page Replacement Policies-FIFO, LRU, Optimal, Counting-based page replacement.	

Unit – V	Contact Hours = 8 Hours
File system: File concept, access methods, directory structure, file system mounting, file sharing, protection. **Disk scheduling**: I/O Devices, Organization of I/O functions, Mass Storage structure-Magnetic disks, Solid-State disks, Magnetic tapes. Disk Scheduling -FCFS, SSTF, SCAN, C-SCAN.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Unit No.	Self-Study Topics
1	History and Evolution of Operating Systems
2	Analyze real-world applications of scheduling algorithms in different OS environments
3	Concurrency and parallelism in modern operating systems
4	Advanced paging techniques like hierarchical paging, inverted page tables, and hashed page tables.
5	Different file systems (NTFS, FAT32, ext4) and their features.

Books	
	Text Books:
1.	Dhananjay M. Dhamdhere, “Operating Systems – A Concept – Based Approach”, Tata McGraw–Hill, 3rdEdition, 2012 and onwards.
2.	Silberschatz, Galvin, Gagne, “Operating System Concepts” John Wiley,6thEdition, 2004 and onwards.
	Reference Books:
1.	William Stallings, “Operating Systems–Internals and Design Principles” Pearson,6th Edition, 2012 and onwards.
2.	Charles Crowley, “Operating Systems-A Design Oriented approach”, McGraw Hill. 2012 and onwards.
3.	H. M. Deitel, P. J.Deitel and David R. Choffnes, “Operating Systems”. PHI,3rdEditionand onwards.
4.	Elmasri, Carrick, Levine, “Operating Systems–Aspiral Approach”,Tata McGraw–Hill,2012 and onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc24_cs108/preview
2.	https://www.nesoacademy.org/cs/03-operating-system

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project

4.	Online classes	4.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the fundamental concepts and terminology related to operating systems and the structure of an operating system.	Un	1,3,5,12	1
2.	Solve the problems on various process scheduling algorithms and memory allocation strategies.	Ap	1,3,5,12	1
3.	Analyze the process synchronization issues and identify and evaluate different solutions for deadlock prevention and deadlock avoidance.	An	1,3,5,12	1
4.	Assess the efficiency and effectiveness of different page replacement policies and disk scheduling algorithm and justify the choice of appropriate strategies in various scenarios.	An	1,3,5,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓		✓		✓							✓	✓		

2	✓		✓		✓							✓	✓		
3	✓		✓		✓							✓	✓		
4	✓		✓		✓							✓	✓		
5															
Tick mark (✓) the CO, PO and PSO mapping															

Power Converters

Course Code	22EC54C	**Course type**	PEC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
				SEE Marks	100

Course Learning Objectives (CLOs)	
1.	To provide a comprehensive understanding of the principles and concepts of power electronics.
2.	To explore problem-solving skills with power electronic circuits and systems.
3.	To foster the ability to select appropriate power electronic components and devices for specific applications.

Pre-requisites: Basic Electronics, Analog Electronic Circuits

Unit – I	**Contact Hours = 8 Hours**
Thyristor: Principles and Characteristics: Introduction, History of Power Electronics Development, Thyristor Family, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, The Two-transistor Model of SCR (Two Transistor Analogy), Gate Characteristics of SCR, Turn-on Methods of a Thyristor, Dynamic Turn-on Switching Characteristics, Turn-off Mechanism (Turn-off Characteristic), Turn-off Methods, Numerical Problems	

Unit – II	**Contact Hours = 8 Hours**
Gate Triggering Circuits: Introduction, Firing of Thyristors, Pulse Transformers, Optical Isolators (Opto-isolators), Gate Trigger Circuits, Unijunction Transistor, The Programmable Unijunction Transistor (PUT), Numerical Problems	

Unit – III	**Contact Hours = 8 Hours**
Phase Controlled Rectifiers: Introduction, Phase Angle Control, Single Phase Half-Wave Controlled Rectifier (One-quadrant), Single-Phase Full-Wave Controlled Rectifier (Two-quadrant Converters), Single-Phase Half Controlled Bridge Rectifier, (R and L Load), Numerical Problems Self-Study: Problem solving with the help of simulation tools and techniques.	

Unit – IV	**Contact Hours = 8 Hours**
Inverters: Introduction, Thyristor Inverter Classification, Series Inverters: Basic Series Inverter, Self-Commutated Inverters, Parallel Inverter: Basic Parallel Inverter Choppers: Introduction, Principle of Chopper Operation, Step-up Choppers, Step-up/down Chopper A. C. Regulators: Introduction, Single-phase A. C. Regulators (With R Load Only), Numerical Problems Self-Study: Problem solving with the help of simulation tools and techniques.	

Unit –V	**Contact Hours = 8 Hours**
Thyristor Applications: Introduction, Overvoltage Protection, Zero Voltage Switch, Integral Cycle Triggering (or Burst Firing), Switched Mode Power Supplies (SMPS), Uninterruptible Power Supplies (UPS), ARC Welding	

Books	
	Text Books:
1.	M. D. Singh, K. B. Khanchandani, "Power Electronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005 onwards
2.	Robert W. Erickson, Dragon Maksimovic, "Fundamentals of Power Electronics", Kluwer Academic Publishers, New York, 2004 onwards
	Reference Books:
1.	Muhammad Rashid, "Power Electronics: Circuits, Devices, and Applications", Pearson Education, 2004 onwards
2.	Dr. P. S. Bimbhra, "Power Electronics", Khanna Publishers, 4th edition onwards
3.	L. Umanand, "Power Electronics – Essentials and Applications", Wiley India Pvt. Ltd, Copyright 2009

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Assignment (OBA)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the fundamental concepts of power electronics, including power semiconductor devices, switching circuits, and converter topologies.	Un	1	1
2.	**Analyze** the dynamic behavior of power electronic circuits and systems.	An	1,2	1
3.	**Analyze** the performance of power electronic systems.	An	1,2,3,5	1
4.	**Evaluate** the impact of power electronics on energy conversion and utilization in different applications.	Ev	1,2,3,5, 7,12	1,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

Embedded System Design

Course Code	22EC54D	Course type	PEC	Credits L-T-P	2-0-1
Hours/week: L - T- P	2 - 0 – 2			Total credits	3
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 20 Hrs Total = 50 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Explain the need and applications of embedded system
2.	Apply Instruction sets for Assembly basics, Instruction list and description.
3.	Analyze Cortex-M3 programming using C language concepts and Microcontroller Software Interface Standard concepts for practical applications.

Pre-requisites:

Unit – I	Contact Hours = 6 Hours
Embedded System basics: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto-coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems	

Unit – II	Contact Hours = 6 Hours
Embedded System firmware and memory: Hardware Software Co-Design, embedded firmware design approaches, computational models, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging, Big and Little Endian formats, Memory (ROM and RAM types)	

Unit – III	Contact Hours = 6 Hours
ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence .	

Unit – IV	Contact Hours = 6 Hours
Instruction Sets: Assembly basics, Instruction list and description, useful instructions. **Communication Interfaces**: I2C, SPI, IrDA, Bluetooth, Wi-Fi, Zigbee only	

Unit – V	Contact Hours = 6 Hours
Programming: Exceptions, Nested Vector interrupt controller design, Timer, Cortex-M3 Programming using assembly and C language	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
5	**5**	1. ALP to multiply two 16 bit binary numbers. 2. ALP to find the sum of first 10 integers. 3. ALP to find the number of 0's and 1's in a 32 bit data. 4. ALP to determine the given 16 bit number is ODD or EVEN. 5. ALP to write data in RAM.
3	**2**	6. Interface and Control a DC Motor. 7. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
1	**3**	8. Interface a DAC and generate Triangular and Square waveforms. 9. Display the Hex digits 0 to F on a 7-segment display interface, with an appropriate delay 10. Measure Ambient temperature using a sensor and SPI ADC

Unit No.	Self-Study Topics
1	PWM
1	Interface a simple Switch and display its status through Relay, Buzzer and LED.

Books	
	Text Books:
1.	K. V. Shibu , "Introduction to embedded systems", TMH education Pvt. Ltd. 2009
2.	Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", Newnes, (Elsevier) 2nd edn, 2010.
3.	James K. Peckol, "Embedded systems - A contemporary design tool", John Wiley, 2008
	Reference Books:
1.	Yifeng Zhu, "Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C", 2nd Ed., Man Press LLC ©, 2015
2.	Rajkamal, "Embedded Systems",2nd Edition, McGraw hill Publications, 2010.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests- Lab based
2.	PPT and Videos	2.	Project phase 1 & 2
3.	Flipped Classes	3.	SEE- Project evaluation
4.	Practice session/Demonstrations in Labs	4.	SEE- Solving an Open ended problem
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:
Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Develop programs using the various instructions of ARM for different Applications.	An	2,3,5	1

2.	Develop the hardware software co-design and firmware design approaches.	An	2,3	1
3.	Analyze the code to optimize the ARM assembly code	An	3,5	1
4.	Develop a project and follow the concept of "Learning by Doing".	Cr	9,10,11	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

LAB (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
Theory IA test should be of one-hour duration. Lab IA test should be of two/three-hour duration. Project batch will ideally consist of 2 students (maximum of 3). Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. Submitting Project report is compulsory.					
Eligibility for SEE: 1. 40% and above (16 marks and above) in LAB component 2. 40% and above (24 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (15 marks write-up + 20 marks algorithm/flowchart + 15 marks execution)	50 marks	100 marks
	Project evaluation a. Initial write up stating the objectives, methodology and the outcome b. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project. c. Viva-voce	10 marks 30 marks 10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1		✓	✓		✓								✓		

2		✓	✓										✓		
3			✓		✓								✓		
4									✓	✓	✓		✓	✓	
Tick mark the CO, PO and PSO mapping															

Digital Image Processing (Lab Based Course)

Course Code	22EC54E	**Course type**	PEC	**Credits L-T-P**	2 – 0 – 2
Hours/week: L - T- P	2 – 0 – 2			**Total credits**	3
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 10 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	8 Hours			**SEE Marks**	100

Course learning objectives	
1.	To explore fundamental image processing system
2.	To study the techniques used for quality enhancement of image
3.	To comprehend image retrieval techniques

Pre-requisites : Signals and systems, Engineering mathematics

Unit – I Introduction to Digital Image Processing	**Contact Hours = 6 Hours**
Introduction to Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization.	

Unit – II Spatial Domain image processing	**Contact Hours = 6 Hours**
Basic Intensity Transformation Functions, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters , Numericals as applicable	

Unit – III Frequency Domain image processing	**Contact Hours = 6 Hours**
Basics of Filtering in the Frequency Domain, Image Smoothing and Image sharpening using frequency domain filters, Numericals as applicable	

Unit – IV Image Restoration	**Contact Hours = 6 Hours**
A model of the Image Degradation/Restoration Process, Noise models, restoration in the presence of noise only using spatial filtering and frequency domain filtering, Minimum Mean Square Error (Wiener) Filtering, numericals as applicable.	

Unit – V Segmentation and feature extraction	**Contact Hours = 6 Hours**
Point, Line, and Edge Detection, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging Region Segmentation Using Clustering and Super pixels, Region Segmentation Using Graph Cuts Feature extraction: Boundary Feature Descriptors, Region Feature Descriptors, Principal Components as Feature Descriptors	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	1	1

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	2	Programs on Basic Relationships and mathematical operations on pixels.
2	2	Programs on Intensity Transformation Functions, Histogram, Spatial domain filters
3	2	Programs on Image filtering
4	2	Programs on image restoration
5	2	Open ended problem statement for real life application of image processing (Ex: Biometric authentication, medical image analysis, image processing in agriculture, etc.)

Unit No.	Self-Study Topics
1.	Arithmetic and Logical operations
2.	Histogram processing
3.	Color Image Processing, Color Fundamentals, Color Models, Pseudo-color image processing
4	Inverse Filtering

Books	
	Text Books:
1.	Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition, 2010.
	Reference Books:
1.	Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL Course, Introduction to Digital Image Processing, https://nptel.ac.in/courses/117105079
2.	Computer Vision and Image Processing, https://nptel.ac.in/courses/108103174

3.	Image Processing and Computer Vision – Matlab and Simulink,
4.	https://in.mathworks.com/solutions/image-video-processing.html

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Assignment (OA)/ Certification
4.	Online classes	4.	Course Project
		5.	Semester End Examination

Course Outcome (COs) **At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)**				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand image formation and visualization in digital domain.	2	1,2,3,5,9,10,12	1
2.	Apply the image quality enhancement techniques to different types of images	3	1,2,3,5,9,10,12	1
3.	Understand image segmentation and analyze restoration methods used in digital image processing	2	1,2,3,5,9,10,12	1

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		**Total**
IA test 1	**IA test 2**	**Assignment (OBA/Lab Project/ Industry assignment)/ Course project**	**Conduction**	**Lab test**	
25 marks	25 marks	10 marks	10 marks	30 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks					

Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 15 marks 5. Viva voce: 10 marks
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component (No change) 2. Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Total. 3. Lab test is COMPULSORY 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓				✓	✓		✓	✓		
2	✓	✓	✓		✓				✓	✓		✓	✓		
3	✓	✓	✓		✓				✓	✓		✓	✓		
Tick mark the CO, PO and PSO mapping															

Multimedia Communication

Course Code	22EC54F	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the fundamental concepts of multimedia, including information representation and networking.
2.	To gain knowledge about digitization principles and the representation of various forms of media
3.	To investigate and apply sophisticated methods for converting analog signals to digital formats, emphasizing high fidelity and data integrity.
4.	To analyze and implement resource management strategies in distributed multimedia systems, optimizing performance and scalability.

Pre-requisites : Digital Signal Processing

Unit – I	**Contact Hours = 8 Hours**
Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology.	

Unit – II	**Contact Hours = 8 Hours**
Introduction, Digitization principles, Text, Images, Audio and Video.	

Unit – III	**Contact Hours = 8 Hours**
Introduction, Compression principles, text compression, image Compression. **Distributed Multimedia Systems:** Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia Operating Systems.	

Unit – IV	**Contact Hours = 8 Hours**
Introduction, Audio compression, video compression, video compression principles, video compression.	

Unit – V	**Contact Hours = 8 Hours**
Introduction, LANs, Ethernet, Token ring, Bridges, FDDI High-speed LANs, LAN protocol **The Internet:** Introduction, IP Datagrams, Fragmentation, IP Address, ARP and RARP, QoS Support, IPv8.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Multimedia Communications- Fred Halsall, Pearson Education, 2001, ISBN -9788131709948
2.	Multimedia Communication Systems- K. R Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson Education, 2004. ISBN - 9788120321458.
3.	**Reference Books:**
4.	Ze-Nian Li and Mark S. Drew, "Fundamentals of Multimedia", Prentice Hall.
	Yao Wang, Joern Ostermann, and Ya-Qin Zhang, Video Processing and Communications, Prentice-Hall, 2002.
1.	**E-resourses (NPTEL/SWAYAM.. Any Other)- mention links**
2.	Multimedia processing https: //nptel.ac.in/courses/117/105/117105083/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Demonstrate a clear understanding of multimedia information representation, networks, and applications.	2	1,2	1
2.	Apply compression principles to text and image data, utilizing appropriate algorithms and techniques..	3	1,2	1
3.	Evaluate the main features, resource management, and networking requirements of distributed multimedia systems.	4	1,2	1
4.				

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓										✓		
2	✓	✓	✓										✓		
3	✓	✓	✓										✓		
4	✓	✓	✓										✓		
5	✓	✓	✓										✓		
Tick mark the CO, PO and PSO mapping															

Cryptography and Network Security

Course Code	22EC54G	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Study the network security model, security attacks, mechanisms and services and to demonstrate use of various symmetric key ciphers and their principles.
2.	Understand the concept of Modular Arithmetic and its application in public key cryptography and apply the knowledge to solve security related problems.
3.	Understand the design principles of Public key cryptosystems for encryption, key exchange and Authentication.
4.	Comprehend the concept of secured electronic transaction with web security considerations.
5.	Study the security threats to networks and their counter measures.

Pre-requisites :

Unit – I	**Contact Hours = 8 Hours**
Security services, mechanisms and attacks, OSI security model, symmetric key cryptography, Substitution techniques: play fair and transposition techniques, SDES: encryption, decryption and key generation, DES: design principles, AES: encryption and decryption model, steganography. Case Study: 1. Perform encryption and decryption on a file using the principle of substitution and transposition cipher. 2. Survey research papers which use multiple techniques to perform image watermarking and Report the findings.	

Unit – II	**Contact Hours = 8 Hours**
Galois fields, extended Euclid's theorem, discrete log problem, Chinese remainder theorem, elliptic curve arithmetic, principles of public key cryptosystems. Case Study: 1. Survey of extended Euclid's algorithm in cryptographic applications. 2. Develop a code to implement ECC algorithm	

Unit – III	**Contact Hours = 8 Hours**
Principles of public-key cryptosystems: public-key cryptosystems, applications for public-key cryptosystems, requirements for public-key cryptography, public-key cryptanalysis, the RSA: description of the algorithm, computational aspects, the security of RSA Algorithm, Daffier Hellman key exchange, cryptographic hash functions: applications of cryptographic hash functions, two simple hash functions, requirements and security, hash functions based on cipher block chaining, secure hash algorithm (SHA).	

Case study: Identify the applications of RSA in public key cryptosystems. Develop a code for implementing simple hash function.

Unit – IV	**Contact Hours = 8 Hours**
Secure socket layer, Transport layer security, and secure hypertext transfer protocol, brief introduction to TCP/IP, Firewalls, IP security, and virtual private networks. Case Study: 1. Demonstration of secure socket layers' applications. 2. Survey and report the recent challenges in secure electronic transactions.	

Unit – V	**Contact Hours = 8 Hours**
Case studies on cryptography and security: introduction, cryptographic solutions, single sign on (SSO), secure intra-branch payment transactions, Denial of services (DoS) attacks, IP spoofing attacks, cross site scripting vulnerability (CSSV) contract signing, secret splitting, virtual electronics, secure multiparty calculation, creating a VPN, cookies and privacy Case Study: 1. Document the history of any two recent viruses and their impact. 2. Identify the limitations of any two antivirus programs.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Unit No.	**Self-Study Topics**
1.	Perform encryption and decryption on a file using the principle of substitution and transposition cipher.
2.	Develop a code to implement ECC algorithm.
3.	Develop a code for implementing simple hash function.
4.	Demonstration of secure socket layers' applications.
5.	Identify the limitations of any two antivirus programs.

Books	
	Text Books:
1.	William Stallings, "Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India, New Delhi, 2002 and onwards.
2.	Behrouz A. Fourouzan, "Cryptography and Network security" Tata McGraw-Hill, 2008 and onwards.
3.	AtulKahate," Cryptography and Network security", 2nd Edition, Tata McGraw-Hill, 2008 and onwards.
	Reference Books:

1.	H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, 2004 and onwards.
2.	Cyber Security Operations Handbook – by J.W. Rittiag house and William M.Hancok – Elsevier's.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs) **At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)**				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Identify and describe different techniques in modern cryptography & Employ the modular arithmetic fundamentals to cryptography.**	**Ap**	**1,2,5,6,10,12**	**1**
2.	**Describe, recognize and use the principles of Public key cryptosystems for various applications including data networks.**	**Ap**	**1,2,5,6,10,12**	**1**
3.	**Analyze the security issues related to internet and networks.**	**An**	**1,2,5,6,10,12**	**1, 2**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-**Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.**

-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.

-Lack of minimum score in IA test will make the student Not Eligible for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.

3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓	✓				✓		✓	✓		
2	✓	✓			✓	✓				✓		✓	✓		
3	✓	✓			✓	✓				✓		✓	✓		
4	✓	✓			✓	✓				✓		✓	✓		
5	✓	✓			✓	✓				✓		✓	✓	✓	
Tick mark the CO, PO and PSO mapping															

Requirements Engineering

Course Code	22EC54H	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course learning objectives	
1.	**To understand the significance of Requirements Engineering and the impact of Requirements Engineering in business development**
2.	**To comprehend the types of requirements and stakeholders involved**
3.	**To study requirements elicitation, documentation and validation techniques**

Unit – I	**Contact Hours = 8 Hours**
Introduction: Definition of Requirements, Why do I need Requirements, Requirements Engineering, problems with requirements, Product/System Development Life Cycle and various approaches, Project management, The business case, Terms of Reference / Project Initiation Document / Project Charter – business objectives, project objectives, scope, constraints (budget, timescale, standards), sponsor (authority), Framework for Requirements Engineering, Actors/ Roles during requirements work.	
Activity: 1. Study the PID for any project and write a summary of the same. Develop an alternate PID for the same and justify why/how the new document is better than the studied one.	

Unit – II	**Contact Hours = 8 Hours**
Types of requirements and Stakeholders : Building the hierarchy through decomposition of requirements, Categories of requirements within the hierarchy, General business requirements, including legal and business policy, Technical policy requirements, Functional requirements, Non-functional requirements, including performance, usability, access, security, archiving, backup and recovery, availability, robustness, Stakeholders, Types of stakeholders and their role and contribution to the requirements engineering process, The Requirements Process . Case Study: Study the Ice Breaker Project (text 2).	
Activity: 1. Identify the stakeholders of the project. Develop the list of stakeholders for any project you identify. Identify their roles and contributions. 2. Build the list of functional and non-functional requirements for any project you identify.	

Unit – III	**Contact Hours = 8 Hours**

Requirements Elicitation: Knowledge types – tacit and non-tacit (explicit), Elements of tacit knowledge that cause problems, Elicitation techniques : Interviews, Workshops, Observation: Formal/informal, Shadowing, Focus groups, Prototyping, Scenarios, Document Analysis **Use of models in Requirements Engineering**: The purpose of modelling requirements, Modelling the business context for the system, Developing a model to represent the system processing requirements, Interpreting a data model.
Activity: 1. Conduct interviews/workshops on the requirements identified for a idea/project. Summarize the outcomes. 2. Develop Prototypes, Scenarios, documents and conduct document analysis for the requirements listed in the above idea/project

Unit – IV	**Contact Hours = 8 Hours**
Requirements Analysis: Organizing requirements, requirements Filters for ensuring well-formed requirements **Requirements Documentation**: The importance of Documentation, Structure of Requirements Document, Requirements catalogue, hierarchy of requirements, Documenting a Requirement-Characteristics of an individual requirement.	
Activity: 1. Prepare a requirements document for any identified idea/project.	

Unit – V	**Contact Hours = 8 Hours**
Requirements Validation: Agreeing the requirements document, Representatives of the review group, Outcomes of a review **Requirements Management**: Dealing with changing requirements, The importance of traceability, Traceability and ownership, Elements of Requirements management, Requirements Engineering support tools.	
Activity: 1. Trace the changes of a requirement identified based on the reviews.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**1**	**1**	**1**	**1**	**1**

Unit No.	**Self-Study Topics**
1	Project Initiation document (PID)
2	Study Of Ice Breaker Project
3	Elicitation technique-Interview
4	Characteristics of an individual requirement
5	Requirements Engineering Support tools

Books	
	Text Books:
1.	Debra Paul, Donald Yeates and James Cadle, Business Analysis, 2nd Edition, BCS Publisher, 2010 and onwards
2.	Suzanne Robertson and James Robertson, "Mastering the Requirements Process", Addison Wesley, 1999 and onwards.
3.	James Cadle, Debbie Paul and Paul Turner, "Business Analysis Techniques: 72 Essential Tools for Success", BCS.
	Reference Books:
1.	Gerald Kotonya and Ian Sommerville, "Requirements Engineering: Processes and Techniques", John Wiley & Sons.
2.	Alistair Cockburn, "Writing Effective Use Cases", Addison-Wesley, 2000 and onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://www.phpkb.com/kb/article/tacit-knowledge-what-is-it-and-how-you-can-promote-it-293.html
2.	https://www.lucidchart.com/pages/uml-use-case-diagram
3.	https://www.knowledgetrain.co.uk/project-management/business-cases/how-to-write-a-business-case
4.	https://openclassrooms.com/en/courses/4544631-learn-the-fundamentals-of-agile-estimation/5371006-discover-the-benefits-of-planning-releases-and-the-pitfalls-of-estimation

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the relevance of requirements engineering in business development	Un	2,6,10,11,12	2,3
2.	Develop a model and analyze the use of a range of requirements elicitation and documentation techniques and the relevance of the techniques to business situations	An	2,6,10,11,12	2,3
3.	Analyze the performance of requirements management process and apply them to manage business requirements.	An	2,6,10,11,12	2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks

Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1		✓				✓				✓	✓	✓		✓	✓
2		✓				✓				✓	✓	✓		✓	✓
3		✓				✓				✓	✓	✓		✓	✓
Tick mark the CO, PO and PSO mapping															

Data Analysis and Visualization with Python

Course Code	22EC54I	Course type	PCC	Credits L-T-P	2-0-1
Hours/week: L - T- P	2 - 0 – 2			Total credits	3
Total Contact Hours	L = 30 Hrs; T = Hrs; P = 20 Hrs Total = 50 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Develop proficiency in interpreting datasets and visualizing trends and patterns.
2.	Effectively apply data cleaning techniques for data preparation.
3.	To critically analyze and evaluate machine learning models for optimal performance.
4.	Apply data analysis techniques to ensure accurate analysis and effective problem-solving.

Pre-requisites: Fundamentals of mathematics, Python programming with OOPS concepts.

Unit – I	Contact Hours = 8 Hours
Introduction to statistics and EDA: Understanding importance of EDA, ecosystem of data science, Understanding data types, statistical analysis: Central tendancy, variance, standard deviation, correlation (mathematical definition with example), Measures of Shape(Skewness, Kurtosis).	

Unit – II	Contact Hours = 8 Hours
Data Cleaning and Preprocessing: Handling missing data and outliers, data normalization and standardization, data transformation techniques, and feature engineering for better analysis.	

Unit – III	Contact Hours = 8 Hours
Univariate Analysis: Descriptive statistics, data visualization using histograms, box plots, and bar charts, probability distributions, and their applications in EDA. **Bivariate and Multivariate Analysis**: Correlation analysis, data visualization techniques for bivariate analysis, and multivariate analysis using scatter plots, pair plots, and heatmaps.	

Unit – IV	Contact Hours = 8 Hours
Supervised Learning: Linear regression, logistic regression, naïve bayes, k nearest neighbour (knn), decision tree(DT), random forest(RF), support vector machine(SVM)	

Unit – V	Contact Hours = 8 Hours
Unsupervised Learning: clustering techniques: centroid based clustering, hierarchical clustering, density based cluster	

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Data loading and preprocessing: Case study
2	1	Applying data preprocessing and feature engineering techniques to a real-world dataset.
3	1	Visualizing univariate, bivariate and multivariate hypothesis
4	1	Implement linear regression and logistic regression
	1	Implement knn algorithm
	1	Implement naïve bayes algorithm
	1	Implement decision tree algorithm
	1	Implement random forest algorithm
	1	Implement SVM algorithm
5	1	Implement k-means clustering algorithm

Unit No.	Self-Study Topics
1	Exploratory Data Analysis Summary
2	Applications, Basics, and Computing of Exploratory Data Analysis
3	Exploratory Data Analysis (EDA) and Repression
5	Hands-On Exploratory Data Analysis with Python

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1	Mukhiya, Suresh Kumar, and Usman Ahmed. *Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data*. Packt Publishing Ltd, 2020.
2.	Ken Black,Applied business Statistics,Wiley India pvt Ltd.
	Reference Books:
1	Atwan, Tarek A. *Time Series Analysis with Python Cookbook: Practical recipes for exploratory data analysis, data preparation, forecasting, and model evaluation*. Packt, 2022.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Python for Data Science, By Prof. Ragunathan Rengasamy, IIT Madras https://onlinecourses.nptel.ac.in/noc22_cs32/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)

3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
5.	**Mini Project**	5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** machine learning concepts and their applications.	Un	1,2,12	1,2
2.	**Apply** supervised learning algorithms for classification and regression tasks.	Ap	1,2,12	1,2
3.	**Analyze** and implement deep learning techniques for complex pattern recognition and image analysis tasks.	An	1,2,12	1,2,3
4.	**Evaluate** and compare machine learning models, addressing overfitting challenges.	Ev	1,2,6,7,9,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
-Theory IA test should be of one-hour duration. -Lab IA test should be of two/three-hour duration. -Project batch will ideally consist of 2 students (maximum of 3). -Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. -Submission of Project report is compulsory.					
Eligibility for SEE: 1. 40% and above (16 marks and above) in theory component 2. 40% and above (24 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (20 marks write-up + 20 marks algorithm/flowchart + 10 marks execution)	50 marks	100 marks
	Project evaluation d. Initial write up stating the objectives, methodology and the outcome	10 marks	

	e. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project. f. Viva-voce	30 marks 10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓							✓	✓	✓	
2	✓	✓			✓							✓	✓	✓	
3	✓	✓			✓		✓	✓	✓	✓		✓	✓		
4	✓	✓			✓							✓	✓	✓	✓

Automotive Cybersecurity

Course Code	22EC54J	**Course type**	PEC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	2 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the Importance of Cybersecurity and System Vulnerabilities
2.	Apply Cryptography Concepts for Data Protection
3.	Analyse Operating System Security and Mitigate Risks
4.	Examine Automotive Hardware Security Mechanisms and Standards Compliance

Pre-requisites : Basic understanding of computers and internet

Unit – I	**Contact Hours = 8 Hours**

Basics of Cyber Security

Various systems which can act as an entry point to cybercriminals. Examples: TV, mobile, vehicle, medical tech, Agriculture, Autonomous factories, etc., System vulnerability to cyberattack, History of cyber-attacks, Introduction to Cyber Security

Symmetric cryptography

Introduction to symmetric key ciphers, Block Cipher/Encryption, Symmetric Encryption Algorithms, Various modes & Use Cases of operation in AES, Performance of each mode of operation in AES

Case Study: Scaling up Application security for a global telecommunications company

Unit – II	**Contact Hours = 8 Hours**

Asymmetric cryptography

Authenticity, Various Asymmetric Encryption Algorithms (RSA, ECDSA, ECC), Introduction to Certificates, Private, Public and Root certificates, MD5/HMAC/SHA sums and protection of these sums using Asymmetric, Application of Asymmetric Keys

Public Key Infra

Private-pub key Generation – SW vs HW, built-in vs HSM, Protection of keys while transport, Protection of keys while storing, Other Security in PKI infra – access control, usage rights, disconnection from NW, Usage of OpenSSL, HSM and built in Key generators to generate keys, Usage True random numbers, Pseudo random numbers in key generations, Introduction to SQlite DBs to save keys securely.

Case Study: Design of PKI system.

Unit – III	**Contact Hours = 8 Hours**

OS principles

Introduction to Linux, Kali Linux, Difference between Kernel space and user space, Shared Process and kernel memory, File systems, Network, Interfaces to OS and IPCs – Demo, Backdoor access to OS – Demo

Case Study: Building a secure OS

Unit – IV	**Contact Hours = 8 Hours**

Hardware Security

Attack over debug port, Attack over open USB/I2C/SPI ports, Attack over memory modules, Attack over display modules, Attack over interface between SOC, External chips (EMMC, GPS, etc), Attack over communication channel between multiple ECU, data transfer access control in ECU (SOC IOC, SOC - any other domain ECU etc.), Importance of secure boot to all HW/ECU/SOCs.

Hardware Security Module (HSM)

Introduction to hardware security module (HSM), need for HSM, HSM - Security features, HSM types - EVITA Profiles

Case Study: Securing digital identities and access control mechanisms for online banking and other financial services

Unit – V	**Contact Hours = 8 Hours**

Cyber Security Standards

Threat analysis and risk assessment (TARA), Cybersecurity assurance level (CAL), Cybersecurity goal, Cybersecurity concept, Cybersecurity incident management, Vulnerability analysis, Cybersecurity assurance case, Privacy assessment as per GDPR

Case Study: Implementation of Cybersecurity standards

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**0**	**0**	**1**	**1**	**0**

Books	
	Text Books:
1.	Cryptography and Network Security Principles and Practice- William Stallings, 8th Edition – Pearson
	Understanding PKI: Concepts, Standards, and Deployment Considerations, 2nd Edition, Released November 2002, Addison-Wesley Professional
	Cryptography and Public Key Infrastructure on the Internet, Klaus Schmeh, 1st Edition, Wiley
	Reference Books:
1.	Cybersecurity: The Essential Body Of Knowledge- Dan Shoemaker, Wm. Arthur Conklin Cengage Learning, 2011
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links

1.	https://www.ssl.com/article/ssl-tls-handshake-ensuring-secure-online-interactions/
2.	https://ieeexplore.ieee.org/document/6407456?denied=

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand Cybersecurity Threats Across Diverse Systems	Un	1,2,4,3,5,6,7,8,9,11	2,3
2.	Apply Cybersecurity Principles to Operating Systems and Hardware	Ap	2,3,4,5,6,7,8,9	2,3
3.	Analyse Cryptographic Solutions in Real-World Applications	An	2,3,4,6,7,8,9,11	2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)	**CO-PSO Mapping (Planned)**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
1	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓	✓
2		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
3		✓	✓	✓		✓	✓	✓	✓		✓		✓	✓
Use tick mark(✓)														

ARM MICROCONTROLLER

Course Code	22EC61	Course type	PCC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 45 Hrs; T = 0 Hrs; P = 0 Hrs Total = 45 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course learning objectives	
1.	To understand need and application of Microcontroller particularly ARM Processors in embedded system design.
2.	To understand architecture and features of typical ARM7 Microcontroller and develop applications using ARM7 Microcontroller.
3.	To learn interfacing of real-world input and output devices to ARM7 Microcontroller and develop applications involving sensors.
4.	To study the assembly instructions of ARM Processor and program using assembly language.

Pre-requisites: Digital Electronic Circuits, C Programming

Unit – I	Contact Hours = 09 Hours
Introduction to Microcomputer Architecture: Microcomputer Organization (CPU, Memory, I/O Devices and Clock), Processor architecture (ALU, Register and Control Unit), Bus Architecture, Processor characteristics, RISC and CISC architectures. **ARM Embedded Systems:** ARM Design philosophy, Embedded System Hardware, Embedded System Software. **ARM Processor Fundamentals:** Registers, Program Status Register, Pipeline.	

Unit – II	Contact Hours = 09 Hours
Architectural overview: Introduction, Features, Block Diagram of LPC2148 - ARM7TDMI-S processor, On-chip flash memory system, On-chip Static RAM (SRAM), Memory Mapping, LPC2148 Pin out. Pin connect Block, General Purpose Input Output (GPIO).	

Unit – III	Contact Hours = 09 Hours
Peripherals -I: Phase Locked Loops (PLL), Timers, PWM and Watch Dog Timer of LPC2148. Embedded 'C' Programming examples. **Exception and Interrupts:** External Interrupt and Vector Interrupt Controller (VIC). Embedded 'C' Programming examples.	

Unit – IV	Contact Hours = 09 Hours
LPC2148 Peripherals -II: Universal Asynchronous Receiver Transmitter (UART), ADC, and DAC. Embedded 'C' Programming examples	

Unit – V	Contact Hours = 09 Hours
Introduction to the ARM assembly programming: Structure of assembly module, Directives, Data processing instructions, Data transfer instructions, Control flow instructions, Writing basic assembly language programs.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Unit No.	Self-Study Topics
1	Survey of various microcontrollers, their specifications, use cases and applications
2	Communication of LPC2148 to the external world through GPIO's using sensors, actuators and display devices
3	Traffic light monitoring system
4	Power management in ARM processors
5	Analysis of assembly vs C programming for code optimization for the given application.

Books	
	Text Books:
1.	Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", ELSEVIER
2.	Steve Furber, "ARM System- on-Chip Architecture" LPE, Second Edition
3.	UM10139 LPC214x User manual
	Reference Books:
1.	William Hohl, "ARM Assembly Language fundamentals and Techniques" CRC press, 2009
2.	Insider's guide to Philips ARM7 based microcontrollers. hitex.co.uk
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL course - Embedded System - https://nptel.ac.in/courses/108102045/5
2.	NPTEL course - ARM Based Development - https://nptel.ac.in/courses/117106111

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Assignment (OA)/ Certification
4.	Online classes	4.	Course Project
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)			
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**

1.	**Identify** a suitable ARM microprocessor based on the features and architecture for the development of an embedded application.	Un	1,2,3,7,12	1
2.	**Develop** the assembly/C program for the given problem/application, and compare the code optimization through the case studies.	Ap	1,2,3,7,9,10,12	1
3.	**Understand** the on-chip peripherals of a microcontroller and **demonstrate and analyse** their interfacing for a given application using ARM7 development boards and Keil simulator.	An	1,2,3,7,9,10,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

- **Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.**
- **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.**
- **Lack of minimum score in IA test will make the student Not Eligible for SEE**
- **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.**

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓				✓					✓	✓		
2	✓	✓	✓		✓		✓		✓	✓		✓	✓		
3	✓	✓	✓		✓		✓		✓	✓		✓	✓		
Tick mark the CO, PO and PSO mapping															

Digital Communication

Course Code	**22EC62**	**Course type**	**IPCC**	**Credits L-T-P**	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand fundamentals of communication channels
2.	To demonstrate application of digital modulation techniques
3.	To analyze the communication system performance for error free transmission

Required Knowledge of: Principles of Communication Systems

Unit – I	**Contact Hours = 8 Hours**
Baseband Transmission: Discrete PAM signals**,** Properties of Line codes, Power Spectral Density of Unipolar, Polar, Bipolar and Manchester RZ and NRZ, ISI in band limited channels, Zero-ISI condition-the Nyquist criterion, Solution for zero ISI, Raised cosine filters, Correlative Coding.	

Unit – II	**Contact Hours = 8 Hours**
Digital Modulation: Geometric Representation of signals, Generation, detection, BER of Coherent BPSK, BFSK, QPSK, QAM, Carrier Synchronization, Structure of Non-coherent Receivers, Principle of DPSK, Introduction to GMSK, MIMO, OFDM and SDR **Activity:** Analysis of signal space diagram for different modulation techniques	

Unit – III	**Contact Hours = 8 Hours**
Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems **Activity: Study the effect of signal jamming**	

Unit – IV	**Contact Hours = 8 Hours**
Review of Information Theory: Review of communication systems, Discrete Communication channels, Channel Matrix, Joint probability matrix, Special channels, System Entropies. Mutual Information, Channel Capacity.	

Unit – V	Contact Hours = 8 Hours
Linear Block codes: Matrix Description of LBC, Encoding, Decoding and Syndrome circuits, Error calculation. **Binary Cyclic Codes:** Properties, Encoding using (n-k) shift registers, Syndrome calculation. **Convolutional Encoding:** Convolutional encoder representation in time and transform domain **Case Study:** Application of Convolutional Coding In MB-OFDM using AI/ML	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**3**	Developing and Testing Building Blocks of Communication Systems PSD of line codes Unipolar, Polar and Bipolar Demonstration of line codes
2	**4**	Transmission and reception of data using PSK modulation using RF link Probability of error and signal space diagram of BPSK, BFSK DPSK Transmission & reception with Constellation Plot Demonstration of QPSK
3	**1**	Generation of PN Sequence (SW)
4	**1**	Determine entropy of communication channel and channel capacity
5	**2**	Linear and Cyclic code generation Syndrome calculation of LBC, Cyclic codes

Unit No.	Self-Study Topics
1	Gram Schmidt orthogonalization
2	Structure of Non-coherent Receivers
3	Synchronization of SS systems
4	System Entropies
5	Transform domain

Books	
	Text Books:
1.	Simon Haykin, “Digital Communications”, John Wiley, 2021 and onwards.
2.	Shu Lin, Daniel J. Costello, “Error Control Coding”, PHI, 2nd Edition, and onwards
3.	George Kennedy, Bernard Davis, SRM Prasanna “Electronics Communication Systems”,5th edition, McGraw Hill Education (India) Pvt. Ltd

	Reference Books:
1.	B. Sklar, "Digital Communication Fundamentals and Applications", 2nd Edition, Pearson Education, 2009 and onwards.
2.	B. P. Lathi, "Modern Digital and Analog Communication Systems" 3rd Edition, Oxford University Press 2007 and onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Introduction to Digital Communication , Prof. Prof. Bikash Kumar Dey, IIT Bombay https://nptel.ac.in/courses/117101051

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	To understand communication system performance	L2	1,2,4,5,10,12	1, 3
2.	Assess channel coding techniques and error detection methods	L3	1,2,4,5,10,12	1, 3
3.	Analyze digital modulation techniques and applications	L4	1,2,4,5,10,12	1,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)		LAB (40 marks)		Total
IA test 1	IA test 2	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 15 marks 5. Viva voce: 10 marks				

Eligibility for SEE:

1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE**
2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.**
3. Lab test is COMPULSORY
4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.**
5. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓		✓					✓	✓		✓	✓		✓
2	✓	✓		✓					✓	✓		✓	✓		✓
3	✓	✓		✓					✓	✓		✓	✓		✓
Use tick mark(✓)															

Employability Skills II

Course Code	**22AECEC66**	**Course type**	**AEC**	**Credits L-T-P**	1 – 0 - 0
Hours/week: L - T- P	1 – 0 – 0			**Total credits**	1
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 0 Hrs Total = 30 Hrs			**CIE Marks**	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	These skills make it easier to form relationships with people, create trust and dependability, and lead teams.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Pre-requisites :

Unit – I	**Contact Hours = 4 Hours**
Quantitative Aptitude**:** Ratios, Proportions and Variations (2 Hours), Partnership (1 Hour), Time and Work (2 Hours) ***Logical Reasoning:*** Seating Arrangement (1 Hour)	

Unit – II	**Contact Hours = 4 Hours**
Quantitative Aptitude**:** Time, Speed and Distance (2 Hours), Trains, Boats and Streams (2 Hours) ***Verbal Ability:*** Reading Comprehension (2 Hours)	

Unit – III	**Contact Hours = 4 Hours**
Quantitative Aptitude**:** Permutation and Combination (2 Hours), Ages (1 Hour) ***Logical Reasoning:*** Data Arrangement (1 Hour) ***Soft Skills:*** Interview Skills (1 Hour), Resume Building (1 Hour).	

Unit – IV	**Contact Hours = 4 Hours**
Quantitative Aptitude**:** Probability (2 Hours) ***Logical Reasoning:*** Clocks and Calendars (2 Hours), Syllogisms (2 Hours)	

Unit – V	**Contact Hours = 4 Hours**
Quantitative Aptitude**:** Data Interpretation (2 Hours) ***Logical Reasoning:*** Data Sufficiency (2 Hours) ***Verbal Ability*****:** Ordering of Sentences (1 Hour), Critical Reasoning (1 Hour)	

Books	
	Text Books:
1.	The Aptitude Triad , BIZOTIC
2.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.
3.	How to prepare for Logical Reasoning for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
4.	How to prepare for Verbal Ability and Reading Comprehension for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 8th Edition, 2018.
5.	How to prepare for Data Interpretation for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 5th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes
		3.	Assignments
		4.	Seminar

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10,12	
2.	Perform confidently during the Interview process	L2	10,12	
3.	Develop resumes that are grammatically correct and written in Business English	L2	10,12	
4.	Develop behaviors that are appropriate for a professional	L2	10,12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two Assignments	Total Marks
Marks	30+30 = 60	20	10+10 =20	100
- Writing 2 IA tests are compulsory **-Student should score minimum 40% of 100 marks to pass the course.**				

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										✓		✓			

2										✓		✓			
3										✓		✓			
4										✓		✓			
Tick mark the CO, PO and PSO mapping															

ARM MICROCONTROLLER LAB

Course Code	**22ECL68**	**Course type**	**PCCL**	**Credits L-T-P**	0 - 0 - 1
Hours/week: L - T- P	0 - 0 - 2			**Total credits**	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			**CIE Marks**	50
				SEE Marks	50

Course learning objectives	
1.	To acquaint students with the fundamentals of ARM processors.
2.	To provide hands on experience to analyze, design and test the programs.
3.	To introduce to the ARM7 microcontroller architecture and its peripherals
4.	To enable the students to design applications and verify the expected outcomes as per the given specifications using ARM7 microcontroller.

Required Knowledge of : Digital Electronic Circuits, C-Programming

Lab Experiment – I	**Contact Hours = 2 Hours**
LED and buzzer interface	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Seven Segment display Interfacing	
Lab Experiment – 3	**Contact Hours = 2 Hours**
Stepper Motor and DC Motor Interfacing	
Lab Experiment – 4	**Contact Hours = 2 Hours**
LCD Interfacing	
Lab Experiment – 5	**Contact Hours = 2 Hours**
On-chip timer and PWM programming	
Lab Experiment – 6	**Contact Hours = 2 Hours**
DAC interfacing to generate waveforms	
Lab Experiment – 7	**Contact Hours = 2 Hours**
Temperature Sensor Interfacing using ADC	
Lab Experiment – 8	**Contact Hours = 2 Hours**
UART Programming	
Lab Experiment – 9	**Contact Hours = 2 Hours**
LED and switch interfacing using interrupt	
Lab Experiment – 10	**Contact Hours = 2 Hours**
Interrupt based programming/interfacing	

Books	
	Text Books:
1.	Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", ELSEVIER
2.	Steve Furber, "ARM System- on-Chip Architecture" LPE, Second Edition
3.	UM10139 LPC214x User manual
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL course - Embedded System - https://nptel.ac.in/courses/108102045/5
2.	NPTEL course - ARM Based Development - https://nptel.ac.in/courses/117106111

Course delivery methods		Assessment methods	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
4.		4.	Lab Test
5.		6.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Experiment with the programming of external input/output devices and sensors to ARM7 microcontroller using embedded 'C' programming language.	L3	1,2,3,5,7,9,10,12	1
2.	Experiment with the on-chip peripherals of ARM7 microcontroller using embedded 'C' programming language.	L3	1,2,3,5,7,9,10,12	1
3.	Design, analyse, and develop applications using ARM7 microcontroller.	L4	1,2,3,5,7,9,10,12	1

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expt	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

4. Conduction of the experiment: 15 marks + Viva voce: 5 marks
5. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks
6. Lab project/ Open ended expt: 10 marks
3. Lab Test: 15 marks

Eligibility for SEE:

2. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

CO-PO Mapping (planned)													CO-PSO Mapping (planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓				✓					✓	✓		
2	✓	✓	✓		✓		✓		✓	✓		✓	✓		
3	✓	✓	✓		✓		✓		✓	✓		✓	✓		
Tick mark the CO, PO and PSO mapping															

Linear Integrated Circuits Design Lab

Course Code	**22ECL69**	**Course type**	**PCCL**	**Credits L-T-P**	0 - 0 - 1
Hours/week: L - T- P	0 - 0 – 2			**Total credits**	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			**CIE Marks**	50
				SEE Marks	50

Course learning objectives	
1.	To apply the principles of operational amplifiers in various analog signal processing and wave shaping applications.
2.	To analyze and evaluate the performance of various operational amplifier-based signal processing and wave shaping circuits.
3.	To design and develop specific linear integrated circuits tailored for particular analog signal processing and wave shaping applications.

Requires Knowledge of: Analog Electronic Circuits

Lab Experiment – 0	**Contact Hours = 2 Hours**
Introduction to operational amplifiers: ideal and practical (Op-Amps), uA-741 – study of datasheet, Inverting and noninverting amplifier and infinite gain amplifier (comparator) and unity gain buffer.	
Lab Experiment – 1	**Contact Hours = 2 Hours**
Mathematical operations using Op-Amps – I: Summing, Scaling, Average and Difference amplifiers.	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Mathematical operations using Op-Amps – II: Active Integrator and differentiator.	
Lab Experiment – 3	**Contact Hours = 2 Hours**
2nd order Active Butterworth Low Pass and High Pass filter design.	
Lab Experiment – 4	**Contact Hours = 2 Hours**
2nd order Active Chebyshev-I Low Pass and High Pass filter design. (Simulation/Spectrum analyser demo)	
Lab Experiment – 5	**Contact Hours = 2 Hours**
Signal conversion circuits: Current to voltage converter and voltage to current converters.	
Lab Experiment – 6	**Contact Hours = 2 Hours**
Timing Circuits: Op-amp based Astable and Monostable multi-vibrator design. **Bi-stable multi-vibrator design (using simulation).**	
Lab Experiment – 7	**Contact Hours = 2 Hours**
Oscillator: RC phase shift oscillator.	
Lab Experiment – 8	**Contact Hours = 2 Hours**
Data Conversion Circuits – I: Analog to digital converter (ADC) – Flash ADC 3 bit (Simulation)	

Lab Experiment – 9	Contact Hours = 2 Hours
Data Conversion Circuits – II: 4 bit R-2R ladder digital to analog converter (DAC)	

Books	
	Text Books:
1.	D. A. Bell, Operational Amplifiers and Linear ICs, Oxford Publications, 2015 onwards.
2.	S. Salivahanan and V. S. K. Bhaskaran, Linear Integrated Circuits, McGraw-Hill Publications, 2017 onwards.
	Reference Books:
1.	Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson Education; Fourth edition, 2015 onwards.
2.	R. F. Coughlin and F. F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, Prentice Hall India, 2000 onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	Integrated Circuits and Applications by Prof. Shaik Rafi Ahamed, IIT Guwahati, link: https://onlinecourses.nptel.ac.in/noc24_ee73/preview

Course delivery methods		Assessment methods	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
		4.	Lab Test
		7.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	**Apply design techniques to develop linear integrated circuit based analog signal processing and wave shaping applications.**	Ap	1,2,3,5,10	1,2
2.	**Analyze and evaluate the performance of various op-amp based signal processing and wave shaping circuits**	Ev	1,2,3,5,10	1,2
3.	**Develop appropriate linear integrated circuits for a specific analog signal processing and wave shaping application.**	Cr	1,2,3,5,10,11	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expt	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:
7. Conduction of the experiment: 15 marks + Viva voce: 5 marks 8. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks 9. Lab project/ Open ended expt: 10 marks 3. Lab Test: 15 marks
Eligibility for SEE:
3. 40% and above (20 marks and above) 2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One-mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓					✓			✓	✓	
2	✓	✓	✓		✓					✓			✓	✓	
3	✓	✓	✓		✓					✓	✓		✓	✓	✓
Tick (✓) mark the CO, PO and PSO mapping															

Electric, Hybrid and Fuel Cell Based Vehicles (EHFCV)

Course Code	22EC63A	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs **Total = 40 Hrs**			**CIE Marks**	100
Flipped Classes Content	08 Hours			**SEE Marks**	100

Course Learning Objectives	
1.	To build basics concepts related to vehicle dynamics, transmission characteristics and various transmission techniques for fossil fuel based vehicles, electric vehicles and hybrid vehicles.
2.	To comprehend the basic concepts related to hybrid braking, regenerative braking and their significance in EV and HEV design and performance.
3.	To compare and contrast various energy sources and propulsion systems for EV, HEV, and FCEV.
4.	To analyze various design and control parameters of electric vehicles, hybrid electric vehicles and fuel cell based vehicles under Indian and global scenarios.

Pre-requisites: Fundamentals of engineering physics, and basic electrical engineering.

Unit I – Basic Vehicular Dynamics, Propulsion & Power Transmission	**Contact Hours = 8**
General descriptions of vehicle movements, vehicle dynamics, brake performance, fuel economy, basics of SI, CI and natural gas engines, vehicle transmission characteristics for ICEV & EV, manual and automatic transmissions, torque converter, automated manual dual clutch transmission (AMT and DCT)	

Unit II – Electrical Energy Sources and Propulsion Systems	**Contact Hours = 8**
Principal Energy Sources (PES) and Peaking Power Sources (PPS) – steady and dynamic components of load power, batteries, hydrogen based PEM fuel cell, ultracapacitors, and ultra-high-speed flywheels Propulsion Systems – motor principle, functioning and speed control of DC motor, induction motor, brushless DC motors (BLDC) and switched reluctance motors (SRM), functioning of rotor position sensor	

Unit III – Electrical and Hybrid EV Basics, & Regenerative Braking	**Contact Hours = 8**
EV – configuration, performance graph, tractive effort in normal driving, energy consumption, concepts of HEV, PHEV, MHEV drivetrains Regenerative Braking – braking energy consumed in urban driving, braking energy and brake power comparison with various parameters, brake system for EV, HEV and FCV Case Study – Toyota Prius, Honda Civic, Ford Escape hybrid architectures	

Unit IV – Series, Parallel and other HEV Architectures	**Contact Hours = 8**
Concept and architecture of hybrid electric drivetrain, series hybrid (electrically coupled) drivetrain, parallel hybrid (mechanically coupled) drivetrain, max SoC of PPS and thermostat control for series hybrid drivetrains, series-parallel (torque-speed) control Case Study – GM 2 mode, Dual-Clutch and Renault mode hybrid transmission	

Unit V – FCHEV Drivetrain Design and Vehicular Energy Management	Contact Hours = 8
Fuel Cell Based HEV – PEMFC characteristics, PEMFC sub-systems, configuration of fuel cell hybrid electric drivetrain design, control strategy, design of motor power, PPS and energy capacity for FCHEV Case study – Vehicular Power Control Strategy & Energy Management : A generic framework, definition and need, methodologies for optimization, cost function optimization, benefits of energy management	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	--	--	3	3	2

Books and Resources	
	Text Books:
1.	Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles," 3rd Edition, CRC Press, Taylor & Francis Group, 2002.
2.	Chris Mi, M. Abul Masrus, David W. Gao, "Hybrid Electric Vehicles – Principles and Applications with Practical Perspectives," 2nd Edition, Wiley, 2017.
3.	Allen E. Fuhs, "Hybrid Vehicles and the future of Personal Transportation," 2nd Edition, CRC Press, Taylor and Francis Group, NW, 2009.
	Reference Books:
1.	John G. Hayes, G. Abas Goodarzi, "Electric Powertrain – Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles"
	E- Resources:
1.	Fundamentals of Electric Vehicles – Technology and Economics - IITM NOC https://www.youtube.com/watch?v=UgtjRob5qMg&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=1 **by Prof. Ashok Jhunjhunwala, IIT Madras**
2.	How Do Electric Vehicles Work? Working Principles of EV-Certified EV Crash Course, 3 Hour video YouTube Link - https://www.youtube.com/watch?v=qIfjibyt6pY

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Offline Quizzes
3.	Flipped Classes	3.	Open Assignment
4.	Online Classes	4.	Course Seminar
5.	Industry Visit	5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**explain** the specific requirements of EV, HEV and FCV for a cleaner environment and **compare** it with pollution caused by ICEV	Un	1,3,6, 7,8,12	1,3

2.	**identify** the importance of various propulsion systems and energy sources & also **justify** the need of infrastructure development for fuel cell based vehicles (FCV) in India	Un	1,2,6, 9,10	1
3.	**develop** sound knowledge related to regenerative braking, hybrid braking & hybrid propulsion systems for modern day vehicles	Ap	1,3,6, 7,8,12	1,3
4.	**distinguish** among the critical design and control parameters for EV, HEV and FCV	An	1,2,3, 5,6,7,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Aassignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE+SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B, and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 question choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 Questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	--	✓	--	--	✓	✓	✓	--	--	--	✓	✓	--	✓
2	✓	✓	--	--	--	✓	--	--	✓	✓	--	--	✓	--	--
3	✓	--	✓	--	--	✓	✓	✓	--	--	--	✓	✓	--	✓
4	✓	✓	✓	--	✓	✓	✓	--	--	--	--	✓	✓	✓	✓

Low Power Architecture

Course Code	22EC63B	**Course type**	PEC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the fundamentals of low-power VLSI design
2.	Familiarity with low-power design techniques and methodologies
3.	Analyze power consumption in CMOS circuits.
4.	Apply low-power techniques in system-level design.

Pre-requisites : Digital System Design, Analog Electronics

Unit – I	**Contact Hours = 8 Hours**
Introduction, Technology and circuit design levels: Device and Technology impact on low power electronics, introduction, dynamic dissipation in CMOS, effects of UN on speed, constraints on reduction, transistor sizing and optimal Gate oxide thickness, impact of technology scaling, technology and device innovations.	

Unit – II	**Contact Hours = 8 Hours**
Low power circuit techniques: Introduction, power consumption in circuits, flip flops and latches, logic, high capacitance notes Low power clock distribution: Power distribution in clock distribution, driver vs distributed buffers, buffer and device sizing under process variation	

Unit – III	**Contact Hours = 8 Hours**
Logic synthesis for low power: Introduction, power estimation techniques, power minimization techniques, Low power memory design: Introduction, sources and reductions of power dissipation in memory subsystem.	

Unit – IV	**Contact Hours = 8 Hours**
Low power microprocessor design: System Power management support, architectural tradeoff for power, choosing the supply voltage, low-power clocking, implementation options for low power, Power and performance, Comparing microprocessors.	

Unit – V	Contact Hours = 8 Hours
Architectural level methodology: Introduction, design floor, algorithm level, Analysis and Optimization, architectural level, Estimation and synthesis. Case Study: Study of QAM block in communication systems.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Unit No.	Self-Study Topics
1	**Problems on Dynamic and static power dissipation**
2	**Clock Distribution schemes**
3	**Power dissipation in memory subsystem.**
4	**Comparing microprocessors**
5	**Study of QAM block in communication systems.**

Books	
	Text Books:
1.	Jan M. Rabaey and Massoud Pedram, "Low-power-design-Methodology", The Springer International Series in Engineering and Computer Science, 1995 and onwards.
2.	Kaushik Roy and Sharat C Prasad, “Low-Power CMOS VLSI Circuit Design”, John Wiley Pvt. Ltd., 2008 and onwards.
	Reference Books:
1.	Gary Yeap and Kluwer, “Practical Low Power Digital VLSI Design”, Academic Publications, 1998 and onwards.
2.	
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/106105034 by **Prof. Ajit Pal**
2.	https://onlinecourses.nptel.ac.in/noc24_ee80/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Assignment (OA)/ Certification
4.	Online classes	4.	Course Project
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Understand the fundamentals of low-power VLSI design.	L2	1	1
2.	Evaluate power-performance trade-offs and understand their impact on circuit design.	L3	2,3	1
3.	Evaluate the suitability of advanced low-power techniques for different design scenarios.	L4	3,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Aassignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE+SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B, and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 question choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 Questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓		
2		✓	✓										✓		
3			✓									✓	✓		
Tick mark the CO, PO and PSO mapping															

Digital System Design on FPGA

Course Code	22EC63C	**Course type**	**Integrated Project based**	**Credits L-T-P**	2-0-1
Hours/week: L - T- P	2 – 0 – 2			**Total credits**	3
Total Contact Hours	L = 30 Hrs; T = 0 Hrs; P = 20 Hrs Total = 50 Hrs			**CIE Marks**	100
Flipped Classes content	3Hours			**SEE Marks**	100

Course learning objectives	
1.	Explain ASIC methodologies, data path elements, logical effort.
2.	Understand and implementing programmable IP flow and also customize the IP.
3.	Analyse back-end physical design flow, including partitioning, floor-planning, placement and routing for area power and timing optimization.
4.	Validate the designs for specific timing and power constraints.

Required Knowledge of : Digital System Design , CMOS VLSI Design, HDL

Unit – I	**Contact Hours = 6 Hours**
State-of-the-Art Programmable Logic: Introduction, The Evolution of Programmable Logic, Current Applications for FPGAs, Application Level System Architectures, FPGA Architecture, System on Chip.	

Unit – II	**Contact Hours = 6 Hours**
IP Flows: Overviews, IP Catalog, IP Customization, IP Constraints, IP-Upgrade Decisions ,IP Simulation. **Processor Options :** Introduction, Computing on FPGAs, Processors on FPGAs, Tool Chains, Beyond Traditional System Design	

Unit – III	**Contact Hours = 6 Hours**
Synthesis: Introduction, Designs Migrating from ASIC, Getting the Most of Device Primitives, Attributes / Directives to Control Synthesis Behavior, Synthesis vs. Simulation Mismatch: Common Cases, Guidelines to Get Best Results Out of Synthesis. **C-Based Design:** C Simulation, Arbitrary Precision Data Types.	

Unit – IV	**Contact Hours = 6 Hours**
Simulation: Introduction, Setting Up Design for Simulation, Simulation and Observing Results. Clocking: Clocking in FPGA Designs, Choice of Clock Frequency, Number of Clocks, Optimizing Clock Networks to Improve Internal Timing.	

Unit – V	**Contact Hours = 6 Hours**
Power Analysis and Optimization: Introduction, Xilinx Power Estimator (XPE), Vivado Report Power, Vivado Power Optimization, **Emulation Using FPGAs:** Introduction to Emulation, Emulation Using FPGAs.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions		2	1		

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**1**	Types of Vivado Programmable Logic, HDL/IP based programs **(2 Experiments)**
2	**3**	IP Customization blocks. **(2 Experiments)**
3	**5**	RTL design and analysis
4	**6**	Synthesizing the code, Simulation and adding constraints
5	**7**	Generating timing reports
5	**8**	Generating power reports
	10	Power Analysis and Power estimation **(2 Experiments)**

Unit No.	Self-Study Topics
1	**Problems on Dynamic and static power dissipation**
2	**Clock Distribution schemes**
3	**Power dissipation in memory subsystem.**
4	**Comparing microprocessors**
5	**Study of QAM block in communication systems.**

Books	
	Text Books:
1.	Jan M. Rabaey and Massoud Pedram, "Low-power-design-Methodology", The Springer International Series in Engineering and Computer Science, 1995 and onwards.
2.	Kaushik Roy and Sharat C Prasad, “Low-Power CMOS VLSI Circuit Design”, John Wiley Pvt. Ltd., 2008 and onwards.
	Reference Books:
1.	Gary Yeap and Kluwer, “Practical Low Power Digital VLSI Design”, Academic Publications, 1998 and onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/106105034 by Prof. Ajit Pal
2.	https://onlinecourses.nptel.ac.in/noc24_ee80/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests- Theory & Lab based
2.	PPT and Videos	2.	Project phase 1 & 2
3.	Flipped Classes	3.	SEE- Project evaluation
4.	Practice session/Demonstrations in Labs	4.	SEE- Solving an Open ended problem
5.	Virtual Labs (if present)		

Course Outcome (COs)
Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the fundamentals of low-power VLSI design.	L2	1	1
2.	Evaluate power-performance trade-offs and understand their impact on circuit design.	L3	2,3	1
3.	Evaluate the suitability of advanced low-power techniques for different design scenarios.	L4	3,12	1

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
Theory IA test should be of one-hour duration. Lab IA test should be of two/three-hour duration. Project batch will ideally consist of 2 students (maximum of 3). Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. Submitting Project report is compulsory.					
Eligibility for SEE: 1. 40% and above (16 marks and above) in theory component 2. 40% and above (24 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (20 marks write-up + 20 marks algorithm/flowchart + 10 marks execution)	50 marks	100 marks
	Project evaluation g. Initial write up stating the objectives, methodology and the outcome	10 marks	
	h. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project.	30 marks	
	i. Viva-voce	10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

CO-PO Mapping (planned)	**CO-PSO Mapping (planned)**

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	✓												✓		
2		✓	✓										✓		
3			✓									✓	✓		
Tick mark the CO, PO and PSO mapping															

Robotics & Automation

Course Code	22EC63D	Course type	PEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	3 Hours			SEE Marks	100

Course learning objectives	
1.	Explain fundamentals of industrial automation and robotics
2.	Identify the faults in the system and troubleshoot them thus learning the complete cycle of building a robot.
3.	Analyze different types of actuators, motors, grippers used in robot drive system and control systems.

Pre-requisites : Digital Electronics, Microcontrollers.

Unit – I	Contact Hours = 8 Hours
Fundamentals of Robot: Introduction, industrial robot, robot, laws of robotics, types of robots, robot specification, benefits of robot, need for robot, manufacturing applications of robot, the future of robotics **Case Study:** Conduct a survey on Non-manufacturing robotic applications.	

Unit – II	Contact Hours = 8 Hours
Robot Drive Systems and End Effectors: Introduction, actuators, types of actuators or drives, DC servomotor, types of D.C. motors, A.C. motors, stepper motor, selection of motors, comparison of pneumatic, hydraulic electrical drives, end-effectors, grippers, classification of grippers, drive system for grippers, types of grippers, hooks scoops, other miscellaneous devices, selection and design considerations of gripper. **Case Study:** Study the control of a two-wheeled robot	

Unit – III	Contact Hours = 8 Hours
Sensors and Machine Vision: Sensors, requirements of sensors, classification of sensors, position sensors, velocity sensor, acceleration sensors, force sensors, external sensors, acquisition of images, machine vision. **Case Study:** Identify an application that uses machine vision for obstruction detection.	

Unit – IV	Contact Hours = 8 Hours
Control Methods: Performance objectives, electrical power, servo-controlled robots, non servo-controlled robots, actuators, controllers, programmable controllers.	

Robot Programming: Introduction, methods for robot programming, defining a robot program, method of defining position in space, motion interpolation, basic programming commands in work-cell control, branching, robot programming languages / textual programming, structure of robot language, VAL programming.

Case Study: Development of robotic arm control system.

Unit –V	**Contact Hours = 8 Hours**

Uses for Robots: Performance objectives, loading and unloading, materials handling, fabricating, assembling, painting, welding, inspecting and testing, the future of flexible automation, objectives of CIM, the future of robots, social impact of robots, new uses and new forms.

Troubleshooting and Maintenance: Performance objectives, preventive maintenance, maintenance of small electric motors, motor problems, common motor problems and their causes, troubleshooting aids, power-supply disturbances, motors with squirrel-cage rotors, testing the centrifugal switch in a single-phase motor, testing for short circuits between run and start windings, capacitor testing, using meters to check for problems, troubleshooting guide.

Case Study: Design a simple automation system that employs the knowledge of sensors and actuators.

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**-**	**2**	**1**	**-**	**-**

Books		
	Text Books:	
1.	Ramachandran S., “Robotics”, AIRWALK PUBLICATIONS (2017), ISBN: 978-9384893-69-9	
2.	Rex Miller, Mark R. Miller - Robots and Robotics_ Principles, Systems, and Industrial Applications-McGraw-Hill Education (2017)	
3.	Mike Wilson - Implementation of Robot Systems_ An introduction to robotics, automation, and successful systems integration in manufacturing-Butterworth Heinemann (2014)	
	Reference Books:	
1.	Lina J. Karam, Naji Mounsef - Introduction to Engineering_ A Starter's Guide with Hands-on Digital and Robotics Explorations (Synthesis Lectures on Engineering)	
2.	John J. Craig - Introduction to Robotics Mechanics and Control 3rd edition-Pearson Education, Inc. (2005)	
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links	
1.	https://nptel.ac.in/courses/108/105/108105063/	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar/Project
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the fundamentals of Robotics.	Un	1,9,10,11,12	1
2.	Compare and identify the appropriate actuators and sensors required for the robotic application.	Ap	2,3,9,10,11,12	1
3.	Analyze and program a controller to sense from sensors and control the actuators.	An	5,9,10,11,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓											✓	**1**		
2		✓	✓										**1**		
3					✓						✓			**1**	
Use tick mark(✓)															

BIO MEDICAL IMAGE UNDERSTANDING AND ANALYSIS

Course Code	**22EC63E**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3 - 0 - 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Identify applications of different Radiological modalities for solving real time problems
2.	Appreciate the use and applications of transforms in extraction of features from objects
3.	Appreciate the evolution of Deep Neural Network from ANN
4.	Design and deploy simple Convolution Neural Network (CNN) model for Biomedical Image classification and identification for specific Radiological Modalities.

Required Knowledge of: Linear Algebra, Statistics and Probability

Unit – I	**Contact Hours = 8 Hours**

Introduction to Biomedical Image Processing

Digital Image Processing, Biomedical Image Processing, System, Medical Image modalities, Image Algebra, Image transform (FT, DCT, DWT, HOUGH, KL) Image Enhancement in spatial and frequency domain, Image Restoration, Medical applications of Imaging, Frontiers of Image processing in Medicine.

Privacy and Ethics in Handling Clinical Data for Experiments: Ensuring privacy and ethics in handling clinical data for experiments is essential to protect patient confidentiality and uphold ethical standards.

Practical Session : Introduction to Mathwork Matlab and Image Processing Toolbox / Python coding

Case study review on Image Morphology, Image Fusion, Image Super Resolution

Unit – II	**Contact Hours = 8 Hours**

Artificial Neural Networks and Evolutions of Deep Learning

Over view of Biological Neural Networks (BNN), McCulloch-Pitts Neuron Model of Biological Neuron, Artificial Neuron Basic Element and its structure, Different activation function, Training, Testing and Validation, Forward and Back propagation with example, Single layer Feed forward network, Multi-layer Feed forward network, classification of learning algorithms, Limitations of Artificial Neural Networks (ANN), Evolutions of Deep Learning.

Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding

Case study review on Artificial Neural Networks and Biomedical Image applications

Unit – III	**Contact Hours = 8 Hours**

Convolution Neural Networks and Applications

Introduction to Convolutional Neural Networks (CNNs / ConvNets), architecture overview and terminologies of CNN, motivation behind CNN, study of architecture and comparisons of pretrained CNN (limited to only **LeNet-5,ResNet -34 and ResNet -50**).

Case study review on to Convolutional Neural Networks (CNNs / ConvNets)and Biomedical Image applications **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding**

Unit – IV	**Contact Hours = 8 Hours**
Deep Learning Medical Image Segmentation Introduction to Digital Image Segmentation, operators - filters for edge and line detection, simple segmentation algorithms, significance of Image Segmentation in Medical Image, classification of digital image segmentation algorithms, automatic image segmentation, Architecture of U-Net and V-net segmentation. **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding** **Case study review on Biomedical Image Segmentation**	

Unit –V	**Contact Hours = 8 Hours**
Deep Learning Medical Image Classification, Analysis and Visualization Features, Features reduction using Principal Component Analysis (PCA), feature reduction using Image Transforms (DWT), Pre trained CNN Model for feature extraction (only **ResNet -50**),Example and demonstration of CNN pretrained model for image classification and Identification. **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding** **Case study review on Pre trained CNN Model**	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Unit No.	**Self-Study Component**
1.	Linear algebra and probability
2.	Learning algorithms and intelligence in algorithm
3.	LeNet -5 CNN Architecture for number classification
4.	Semantic Segmentation and nnU-net
5.	Clustering algorithm for image classification in Biomedical Imagery applications

Books	
	Text Books:
1.	Geoff Dougherty, "Digital Image Processing for Medical Applications", Cambridge University Press, 2nd Edition, 2013.
2.	Kevin Zhou, Medical Image Recognition, Segmentation and Parsing: Machine Learning and Multiple Object Approaches, 1st Edition, Elsevier Science, 2015
	Reference Books:

1.	Kevin Zhou, Hayit Greenspan and Dinggang Shen, Deep Learning for Medical Image Analysis Elsevier Science, 2017
2.	Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Debdoot Sheet, Indian Institute of Technology Kharagpur, MEDICAL IMAGE ANALYSIS, NPTEL course Link: https://nptel.ac.in/courses/108/105/108105091/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	**Mini Project**		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply knowledge of deep learning algorithms to solve real life problems related to health care and radiology.	Ap	1,2,12	1,2
2.	Analyze the state of art techniques applied in deep learning research	An	1,2,12	1,2
3.	Evaluate the effectiveness of deep learning models in healthcare classification and identification using suitable datasets.	Ev	1,2,3,5,6,8,12	1,2,3
4.	Analyze different deep learning models for different applications of Diseases detection and identification using Computed tomography (CT) and Magnetic Resonance Imaging (MRI).	An	1,2,3,5,6,8,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.

-Lack of minimum score in IA test will make the student Not Eligible for SEE

-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓							✓	✓	✓	
2	✓	✓			✓							✓	✓	✓	
3	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
4	✓	✓		✓	✓	✓		✓				✓	✓	✓	✓

Adaptive Digital Signal Processing

Course Code	**22EC63F**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 45 Hrs; T = 0 Hrs; P = 0 Hrs Total = 45 Hrs			**CIE Marks**	100
Flipped Classes content	05 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand meaning of "adaption" in terms of signal processing and geometrical terms.
2.	Analyze basic non-recursive adaptive filter, that is, the adaptive linear combiner.
3.	Understand performance or error surface under stationary and non-stationary conditions.
4.	Understand LMS algorithms and other types of adaptive algorithms.
5.	Understand adaptive modelling and system identification; inverse adaptive modelling, deconvolution and equalization.

Pre-requisites: Signals and Systems, Digital Signal Processing,

Unit - I	**9 Hours**
Adaptive systems: Definitions and characteristics - applications - properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction – linear optimum filtering-orthogonality – WienerHopf equation- Performance Surface. (Text 1)	

Unit - II	**9 Hours**
Searching performance surface-stability and rate of convergence: learning curve-gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty - variance - excess MSE and time constants – misadjustments. (Text 1)	

Unit - III	**9 Hours**
LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm – adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals. (Text 1)	

Unit - IV	**9 Hours**
Applications-adaptive modelling: Multipath communication channel, geophysical exploration, FIR digital filter synthesis. (Text 2)	

Unit - V	**9 Hours**
System identification-adaptive modelling: Inverse adaptive modelling, equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis. (Text 2)	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Simon Haykin, **"Adaptive Filter Theory"**, Pearson Education, 2003.
2.	Bernard Widrow and Samuel D. Stearns, **"Adaptive Signal Processing"**, Person Education, 2005.
	Reference Books:
1.	John R.Treichler, C.Richard Johnson, Michael G.Larimore, **"Theory and Design of Adaptive Filters"**, Prentice-Hall of India,2002
2.	S.Thomas Alexander, "Adaptive Signal Processing-Theory and Application", Springer-Verlag.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Introduction To Adaptive Signal Processing by Prof. Mrityunjoy Chakraborty, IIT Kharagpur Link: https://onlinecourses.nptel.ac.in/noc23_ee138/preview

Course delivery methods

1. Blackboard Teaching
2. Presentations

Assessment methods

1. Internal Assessment
2. Assignment
3. Activity

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Design optimal minimum mean square estimators and in particular linear estimators.	Ap	1,2,3,5,10	1,2
2.	Implement adaptive filters (FIR, IIR, non-causal, causal) and evaluate their performance.	Ap	1,2,3,5,10	1,2
3.	Identify applications in which it would be possible to use the different adaptive filtering approaches.	An	1,2,3,5,10	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓		✓										✓		
2	✓		✓										✓		
3	✓	✓	✓										✓	✓	✓
Tick mark the CO, PO and PSO mapping															

Internet of Things and Cyber Physical Systems

Course Code	**22EC63G**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Students will be able to define the Internet of Things (IoT), describe its key characteristics, and differentiate it from Machine-to-Machine (M2M) communication.
2.	Students will gain an understanding of smart objects, sensors, actuators, and the criteria for connecting these objects within IoT frameworks.
3.	Students will understand the key design drivers, quality attributes, and high-confidence attributes of Cyber-Physical Systems, particularly in energy, medical, and transportation applications.
4.	Students will explore the architecture, node connectivity, networking, and security aspects of Wireless Sensor Networks (WSN).
5.	Students will investigate various IoT applications across different industries, understand basic and advanced cybersecurity techniques, and identify open challenges in securing Cyber-Physical Systems.

Pre-requisites : Basics of Electronics and Embedded System

Unit – I	**Contact Hours = 8 Hours**
Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Machine to Machine, Difference between IoT and M2M **Smart Objects**: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.	

Unit – II	**Contact Hours = 8 Hours**
Motivation and examples of CPS e.g. Energy, Medical and Transportation cyber physical systems; Key design drivers and quality attributes of CPS. Attributes of high confidence CPS. **Case Study: Identify an application and analyze its performance using any two-network models.**	

Unit – III	**Contact Hours = 8 Hours**
Wireless Sensor Networks: WSN Architecture, the node, connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security **Case Study- Survey on real time challenges with respect to Security in WSN.**	

Unit – IV	Contact Hours = 8 Hours
Security of Cyber-Physical Systems: Basic Techniques Cyber Security Requirements, Attack Model, Countermeasures, Advanced Techniques, System Theoretic Approaches. **Case Study: Open Challenges / Problems of CPS**	

Unit – V	Contact Hours = 8 Hours
IoT and CPS Applications: IoT for Retailing Industry, IoT For Oil and Gas Industry, Data Aggregation for the IoT in Smart Cities, Agriculture: Smart Irrigation **Case Study: IOT in Autonomous Cars and Transportation**	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions				**2**	**2**

Books	
	Text Books:
1.	Kamal, R., (2017), Internet of Things - Architecture and Design Principles, 1st Edition, Mcgraw Hill onwards
2.	R. Rajkumar, D. de. Niz and M. Klein, (2017), Cyber Physical Systems, addisionwesely onwards.
	Reference Books:
1.	E.A.Lee and S A Shesia, (2018), Embedded system Design: A Cyber-Physical Approach, Second Edition, MIT Press onwards.
2.	A.Platzer, (2017), Logical Foundations of Cyber Physical Systems, Springer.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8d242f72a43188a1258b1332a3c9bf90f26db103

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand fundamental IoT and CPS concepts, including design and functional differences between IoT and M2M.**	L2	1,2,4,5	1
2.	**Design and implement sensor networks, and analyze CPS performance in practical applications.**	L3	1,2,4,5	1
3.	**Identify WSN and CPS security challenges and develop advanced security strategies through case studies.**	L3	1,2,4,5	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓	✓	✓							✓	✓		
2	✓	✓	✓	✓	✓					✓	✓	✓	✓		
3	✓	✓	✓	✓	✓					✓	✓	✓	✓		
Use tick mark(✓)															

Computational Intelligence and Applications

Course Code	22EC63H	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Develop a comprehensive understanding of computational intelligence, fuzzy logic, and neural networks.
2.	Explore and analyse various neural network architectures and their applications.
3.	Acquire in-depth knowledge of the fundamental principles, concepts, and operations of fuzzy logic.
4.	Design and implement effective fuzzy logic systems, including creating rule bases, defining membership functions, and implementing fuzzy inference mechanisms.

Pre-requisites : Mathematical fundaments and set theory, fundamentals of Linear Algebra

Unit – I	**Contact Hours = 8 Hours**
Introduction to Computational Intelligence Overview of computational intelligence and its applications, Introduction to neural networks, fuzzy logic, evolutionary computation, swarm intelligence, and machine learning. **Case study on Energy Management in Smart Grids using computational intelligence.**	

Unit – II	**Contact Hours = 8 Hours**
Fundamentals of Artificial Neural Network Perceptron, artificial neuron, artificial neuron implementation, different activation functions for binary and multilabelled classification. Logic development using simple perceptron, single layer perceptron, multilayer perceptron, artificial neural learning, forward propagation and back propagation algorithm and application. **Applications of Artificial Neural Networks (ANNs)** Image and Speech Recognition, Natural Language Processing, Time Series Prediction, Pattern Recognition and Classification. **Case study on Fraud Detection in Financial Transactions using computational intelligence.**	

Unit – III	**Contact Hours = 8 Hours**
Fuzzy Set theory and Fuzzy System **Fuzzy set theory:** Introduction to Fuzzy Set, Membership, Operations, Properties, Fuzzy Relation. **Fuzzy system:** Introduction, FL, Fuzzification, Fuzzy Inference, F Rule Based System, Defuzzification. **Applications of fuzzy system:**	

Fuzzy rule-based traffic signal optimization, Fuzzy logic-based medical diagnosis systems, Fuzzy logic-based power system stability analysis, Fuzzy rule-based decision support systems for financial risk assessment.

Case study on Medical Diagnosis and Treatment using computational intelligence.

Unit – IV	**Contact Hours = 8 Hours**

Associative Memory

Fuzzy Associative Memory, - Fuzzy associative memories (FAMs) pattern recognition and retrieval in fuzzy logic systems and Associative Neural Memory.

Applications of Associative Memory: Efficient data storage and retrieval in large-scale databases, Image and video processing for object recognition and tracking, Speech recognition and natural language processing, financial forecasting and time series analysis, Fault diagnosis and anomaly detection in complex systems.

Case study on Autonomous Vehicle Navigation using computational intelligence.

Unit – V	**Contact Hours = 8 Hours**

Applications of Neuro-Fuzzy

Neuro-Fuzzy System Fundamentals, Neuro-Fuzzy Modeling, Neuro-Fuzzy Pattern Recognition application, Neuro-Fuzzy Time Series Prediction and analysis, Neuro-Fuzzy Fault Diagnosis and Neuro-Fuzzy Applications in Healthcare.

Case study on Predictive Maintenance in Manufacturing using computational intelligence.

Unit No.	**Self-Study Topics**
1	Exponential models, Time series models.
2	Multiple linear regression, Multivariate linear regression, Generalized linear models.
3	Machine learning and compressed sensing.
5	Sparse signal representation, kernel and sparse kernel

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions **Mini -Project and Case Study in each Unit**	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Andries P. Engelbrecht, "Computational Intelligence: An Introduction, Second Edition", Wiley, 2007.
2.	Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Pearson, 2008.
	Reference Books:

1.	Nikola K. Kasabov, "Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering", MIT Press, 1996.
2.	Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall, 1992.
3.	Bart Kosko, "Fuzzy Engineering", Prentice Hall, 1997.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Approximate Reasoning Using Fuzzy Set Theory, By Prof. Balasubramaniam Jayaram, IIT Hyderabad https://onlinecourses.nptel.ac.in/noc23_ma60/preview
2.	Introduction To Fuzzy Set Theory, Arithmetic And Logic, By Prof. Niladri Chatterjee, IIT Delhi https://onlinecourses.nptel.ac.in/noc23_ma73/preview
3.	Deep Learning for Computer Vision, By Prof. Vineeth N Balasubramanian, IIT Hyderabad https://onlinecourses.nptel.ac.in/noc21_cs93/preview

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
5.		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the foundational principles and concepts of computational intelligence, including neural networks and fuzzy logic.	**Re**	1,2, 12	1,2
2.	Apply computational intelligence techniques effectively to solve complex problems.	**Ap**	1,2, 12	1,2
3.	Analyze and evaluate computational intelligence algorithms and models critically.	**An**	1,2,12	1,2,3
4.	Design and implement innovative computational intelligence solutions for real time application.	**An**	1,2,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓										✓	✓		
2	✓	✓										✓	✓		
3	✓	✓					✓					✓	✓	✓	✓
4	✓	✓										✓	✓	✓	✓
Tick mark the CO, PO and PSO mapping															

Database Management System

Course Code	22EC63I	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the fundamental concepts of database management systems, including data models, schema design, and relational algebra.
2.	To develop proficiency in querying databases using Structured Query Language (SQL).
3.	To Explore advanced topics in DBMS, such as transaction management, concurrency control.
4.	To study the concepts of database normalization.

Pre-requisites : Basic Computer Knowledge

Unit – I	**Contact Hours = 8 Hours**
Introduction: Characteristics of database, Advantages of using DBMS approach, when not to use a DBMS, Types of databases, A brief history of database applications, Data models, Schemas and instances, Three-schema architecture and data independence	

Unit – II	**Contact Hours = 8 Hours**
Entity-Relationship model: Using high-level conceptual data models for database design, an example database application, Entity types, Entity sets, Attributes and keys, Relationship types, Relationship Sets, Roles and structural constraints, Weak entity types, ER diagrams, Naming conventions and design issues. Develop a ER model for COMPANY database	

Unit – III	**Contact Hours = 8 Hours**
Relational model and relational algebra: Relational model concepts, Relational model constraints and relational database schemas, Update operations, Unary relational operations: SELECT and PROJECT, Relational algebra operations from set theory, Examples of queries in relational algebra.	

Unit – IV	**Contact Hours = 8 Hours**
SQL:SQL data definition and data types, Specifying basic constraints in SQL, Schema change statements in SQL, Basic queries in SQL, more complex SQL queries.	

Unit – V	**Contact Hours = 8 Hours**
Database design: Informal design guidelines for relation schemas, Functional dependencies, Normal forms 1NF, 2NF and 3NF, Boyce-Codd normal form.	

Introduction to transaction processing concepts and theory: Transaction and system concepts. Introduction to concurrency control techniques.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Unit No.	Self-Study Topics
1	Actors/Roles involved in using database
2	Refining the ER design
3	Binary relational operations: JOIN and DIVISION;
4	SQL queries
5	Concurrency control techniques

Books	
	Text Books:
1.	Elmasri and Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2007and onwards
	Reference Books:
1.	Silberschatz, Korth and Sudharshan, "Data base System Concepts", 6th Edition, Mc-GrawHill, 2010and onwards.
2.	C. J. Date, A. Kannan andS. Swamynatham, "An Introduction to Database Systems", 8th Edition,Pearson Education, 2006and onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/noc22_cs91/preview (Data Base Management System)
2.	https://nptel.ac.in/courses/106104135 (Data Base Management System)

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)			
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**

1.	Develop a foundation in the core principles and building blocks of DBMS. This includes understanding how data is organized,	Un	1,2,3, 5	1
2.	Gain insights into concurrency control mechanisms, which are essential for maintaining data consistency when multiple users access the database simultaneously.	Un	1,2,3, 5,12	1
3.	Apply DBMS concepts to write queries using a Structured Query Language (SQL), the industry standard for interacting with relational databases.	Ap	1,2,3, 5,12	1
4.	Analyze normalization techniques, a set of rules for structuring database tables to minimize redundancy and improve data integrity.	An	1,2,3, 5,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.

-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.

-Lack of minimum score in IA test will make the student Not Eligible for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓								✓		
2	✓	✓	✓		✓							✓	✓		
3	✓	✓	✓		✓							✓	✓		
4	✓	✓	✓		✓							✓	✓		
Tick mark the CO, PO and PSO mapping															

Digital Forensics

Course Code	22EC63J	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the key aspects of Digital Forensics.
2.	To study the nature of a typical digital forensics case, the correct procedures for searching and seizing evidence and evaluation of a case.
3.	To study the E-mail and Social Media Investigations related to Digital Forensics.
4.	To comprehend the Mobile Device Forensics and Cloud Forensics.

Pre-requisites : Introduction to cyber security

Unit – I	**Contact Hours = 8 Hours**
Understanding the digital forensics profession and investigations: an overview of digital forensics, preparing for digital investigations, maintaining professional conduct, preparing a digital forensics investigation, procedures for private-sector high-tech investigations, understanding data recovery workstations and software, conducting an investigation. Data acquisition: understanding storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, using acquisition tools. Case Study: Study of Redundant Array of Independent Disks (RAID) Data Acquisition from a computer.	

Unit – II	**Contact Hours = 8 Hours**
Processing crime and incident scenes: identifying digital evidence, collecting evidence in private sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case. Case Study: Study of Secure Hashing-1, Message Digest 5 algorithms and parameters	

Unit – III	**Contact Hours = 8 Hours**
Working with windows and Command Line Interface systems: understanding file systems, exploring Microsoft file structures, examining NTFS disks, understanding whole disk encryption, understanding the windows registry, understanding virtual machines. Digital forensics analysis: determining what data to collect and analyze, addressing data-hiding techniques. Case study: Understanding bootstrap loader sequence in a computer.	

Unit – IV	Contact Hours = 8 Hours
E-mail and social media investigations: exploring the role of e-mail in investigations, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensics tools, applying digital forensics to social media. Case Study: 1. Study of "Elephant in the Room: Case Studies of Social Media in Civil and Criminal Cases," Mark Lanterman, http://blog.x1discovery.com/2014/06/10/elephantin-the-room-case-studies-of-social-media-in-civil-and-criminal-cases/, June 2014. 2. Demonstrate the use of Forensic Toolkit (for Face book by Afentis Software) to discover friends and other information of a public profile.	

Unit – V	Contact Hours = 8 Hours
Mobile device forensics: understanding mobile device forensics, understanding acquisition procedures for mobile devices, process of mobile device forensics. Cloud forensics: an overview of cloud computing, legal challenges in cloud forensics, technical challenges in cloud forensics, acquisitions in the cloud, conducting a cloud investigation, tools for cloud forensics Case Study: Study of SIM Manager tool to read the sim card messages. And benefits and challenges of mobile device forensics.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Unit No.	Self-Study Topics
1	Redundant Array of Independent Disks (RAID)
2	Digital forensics analysis
3	Develop a code for implementing simple hash function.
4	Using OS Forensics to Recover E-mail
5	SIM Manager tool to read the sim card messages

Books	
	Text Books:
1.	Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations: Processing Digital Evidence", Fifth Edition, Cengage Learning, 2015 and onwards.
2.	Cory Altheide, Harlan Carvey, "Digital Forensics with Open Source Tools", Elsevier, Syngress publications, 2011 and onwards.
	Reference Books:
1.	John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Second Edition, ISBN 1-58450-389-0, 2005 and onwards.
	E-resources (NPTEL/SWAYAM. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the basic concepts of digital forensics and study the forensic tools.	APP	1,3,4,5,6,8	1
2.	Analyze the forensic data acquired from an electronic system.	An	1,3,4,5,6,8	1
3.	Analyze the e-mail and social media digital forensics and document.	An	1,3,4,5,6,8	1
4.	Understand the digital forensics applied to mobile and cloud scenario.	Un	1,3,4,5,6,8	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours' duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	✓		✓	✓	✓	✓		✓					✓		
2	✓		✓	✓	✓	✓		✓					✓		
3	✓		✓	✓	✓	✓		✓					✓		
4	✓		✓	✓	✓	✓		✓					✓		
Tick mark the CO, PO and PSO mapping															

Human Computer Interaction

Course Code	22EC641	**Course type**	OEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	2 Hours			**SEE Marks**	100

Course learning objectives	
1.	Learn the basics of human-computer interaction, interactivity, interaction styles, models of interaction and framework of human-computer interaction.
2.	Study how software engineering and the design process relate to interactive system design and understand the design rules to develop an effective design process and a universal design.
3.	Learn the programming support tools available for implementing interactive systems and improve the abstraction by use of toolkits. Study the evaluation techniques and design of user support systems.
4.	Study the implementation and applications of groupware, ubiquitous computing and augmented realities applied to interactive systems.

Pre-requisites : Nil

Unit – I	**Contact Hours = 8 Hours**
Foundation: Introduction to human and computer, The Interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of WIMP interface, Interactivity. **Case Study**: Paradigms for interaction	

Unit – II	**Contact Hours = 8 Hours**
The Design Process: Interaction design basics: the process of design, user focus, scenarios, navigation design, screen design and layout, iteration and prototyping. HCI in software process: software life cycle, usability engineering, iterative design and prototyping, design rationale. Design rules: principles, standards, guidelines, golden rules and heuristics, HCI patterns. Universal design: Universal design principles, Multi-modal interaction. **Case Study**: Designing for diversity	

Unit – III	**Contact Hours = 8 Hours**
Models of Interactive Systems: Standard formalism, Cognitive models: Goal and task hierarchies, Linguistic models, challenge of display-based systems, Physical and device models, and Cognitive architectures. Interaction models, modeling rich interaction. **Case Study**: Socio-organizational issues and stakeholder requirements	

Unit – IV	Contact Hours = 8 Hours
Implementation and Evaluation: Implementation support: Elements of windowing systems, Programming the application, using toolkits, User interface management systems. Evaluation techniques: Goals of evaluation, Evaluation through expert analysis, choosing an evaluation method. User support: Requirements of user support, Approaches to user support, Adaptive help systems, Design of user support systems. **Case Study**: Evaluation through user participation	

Unit – V	Contact Hours = 8 Hours
Interactive System Applications: Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, implementing synchronous groupware. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. **Case Study**: Hypertext, Multimedia and the World Wide Web	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	0	0	1	1	0

Books	
	Text Books:
1.	Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russell Beale, “Human-Computer Interaction”, 3rd Edition, Pearson Education Limited, 2004.
	Reference Books:
1.	Preece, J., Rogers, Y., & Sharp, H., “Interaction design: Beyond human-computer interaction”, 4th Edition, John Wiley & Sons Limited, 2015.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://www.hcibook.com/e3/online/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Understand the basic elements of human-computer interaction.	Un	1,6,8,9,10,11,12	1,3

2.	Analyze different models of interactive systems and their implementation and evaluation.	An	1,2,6,8,9,10,11,12	2,3
3.	Apply groupware, ubiquitous computing and augmented reality technologies in an interactive system.	Ap	1,2,6,8,9,10,11,12	1,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours' duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓					✓		✓	✓	✓	✓	✓	✓		✓
2	✓	✓				✓		✓	✓	✓	✓	✓		✓	✓
3	✓	✓				✓		✓	✓	✓	✓	✓	✓		✓
Use tick mark(✓)															

EMBEDDED SYSTEMS WITH ARDUINO

Course Code	**22EC642**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Identify the embedded system devices from the real world.
2.	Make use of Arduino software/hardware platform and explain the basics of Arduino platform
3.	Define robotics, its terminologies and basic sensors used in robotics
4.	Build a simple robot using Arduino considering real world problems

Pre-requisites: Microcontroller

Unit – I	**Contact Hours = 8 Hours**
Embedded system: History, Block diagram, Comparison with general purpose computers, classification, applications. Case study: Washing Machine, traffic light controller and microwave oven(functional diagram level)	

Unit – II	**Contact Hours = 8 Hours**
Arduino: IDE, I/O Functions, Looping Techniques, Decision Making Techniques Designing of 1st sketch Programming of an Arduino (Arduino ISP), Arduino Boot loader, Serial Protocol (serial port Interfacing), Initialization of Serial Port using Functions, Basic Circuit for Arduino	

Unit – III	**Contact Hours = 8 Hours**
Basic Interfacing and I/O Concept Interfacing of: LED, Switch, keypad, LM35,Motor Driver L293D, IR Sensor, Interfacing L293D with Arduino with relevant program and connection diagram.	

Unit – IV	**Contact Hours = 8 Hours**
History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Specifications of robot. Definition of Forward and Reverse Kinematics	

Unit – V	**Contact Hours = 8 Hours**

Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors. Case Study: Implementation of small project demonstration of robot (line follower robot, robotic arm) using Arduino

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Introduction to Embedded Systems, Shibu K. V., Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790
2.	Rex Miller, Mark R. Miller - Robots and Robotics_ Principles, Systems, and Industrial Applications-McGraw-Hill Education (2017)
3.	Arduino-Based Embedded Systems: By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
4.	Mike Cheich," Arduino book for beginners", Programming electronics academy, 2021
5.	Jeremy Blum, "Exploring Arduino: Tools and Techniques for Engineering, Wiley, 2013
	Reference Books:
1.	Neeparaj Rai, " arduino projects for beginners" ,BPB Publications
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.swayam2.ac.in/aic20_sp04/preview (Arduino, IIT Bombay)

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar/Course Project
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Explain and distinguish the components of embedded system with the help of applications	Un	2,9,10,11,12	1
2.	Apply the concepts of software & hardware structure of the Arduino and interface peripherals	Ap	2,5,9,10,11,12	1

3.	Apply the knowledge of embedded concepts and Arduino to design embedded robotic systems.	An	5,9,10,11,12	2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours' duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1		✓							✓	✓	✓	✓	✓		
2		✓			✓				✓	✓	✓	✓	✓		
3					✓				✓	✓	✓	✓		✓	
Use tick mark(✓)															

Digital Image Processing

Course Code	22EC643	**Course type**	OEC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To explore fundamental image processing system
2.	To study the techniques used for quality enhancement of image
3.	To comprehend image retrieval techniques

Pre-requisites: Signals and systems, Engineering mathematics

Unit – I Introduction to Digital Image Processing	Contact Hours = 8 Hours
Introduction to Digital Image Processing Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels. Self-study topics: Arithmetic and Logical operations Demo of MATLAB programs on Basic Relationships Between Pixels.	

Unit – II Spatial Domain image processing	Contact Hours = 8 Hours
Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters Demo of MATLAB programs on Intensity Transformation Functions, Histogram, Spatial domain filters	

Unit – III Frequency Domain image processing	Contact Hours = 8 Hours
Basics of Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters. Color Image Processing: Color Fundamentals, Color Models, Pseudo-color Image Processing.	

Unit – IV Image Restoration	Contact Hours = 8 Hours
A model of the Image Degradation/Restoration Process, Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. Demo of MATLAB programs on image restoration	

Unit – V Color Image Processing	Contact Hours = 8 Hours
Color Fundamentals, Color Models, Pseudo-color Image Processing. Basics of Full-Color Image Processing, Color Transformations, Color Image Smoothing and Sharpening Demo of MATLAB programs on Pseudo-color Image Processing	

Books	
	Text Books:
1.	Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition, 2010.
	Reference Books:
2.	Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.
	E-resources (NPTEL/SWAYAM.. Any Other
1.	NPTEL Course, Introduction to Digital Image Processing, IIT Kharagpur, Prof. P.K. Biswas https://nptel.ac.in/courses/117105079
2.	Computer Vision and Image Processing, IIT Guwahati, Prof. M. K. Bhuyan https://nptel.ac.in/courses/108103174
3.	On ramp course: Image Processing and Computer Vision – Matlab and Simulink, https://in.mathworks.com/solutions/image-video-processing.html

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Assignment (OA)/ Certification
4.	Online classes	4.	Course Project
		5.	Semester End Examination

Course Outcome (COs) **At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)**				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand image formation and visualization in digital domain.	2	1,2,3,5,9,10,12	1
2.	Understand image segmentation and analyze restoration methods used in digital image processing	2	1,2,3,5,9,10,12	1
3.	Apply the image quality enhancement techniques to different types of images	3	1,2,3,5,9,10,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

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-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours' duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓				✓	✓		✓	✓		
2	✓	✓	✓		✓				✓	✓		✓	✓		
3	✓	✓	✓		✓				✓	✓		✓	✓		
Tick mark the CO, PO and PSO mapping															

Requirements Engineering

Course Code	22EC644	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course learning objectives	
1.	**To understand the significance of Requirements Engineering and the impact of Requirements Engineering in business development**
2.	**To comprehend the types of requirements and stakeholders involved**
3.	**To study requirements elicitation, documentation and validation techniques**

Unit – I	**Contact Hours = 8 Hours**
Introduction: Definition of Requirements, Why do I need Requirements, Requirements Engineering, problems with requirements, Product/System Development Life Cycle and various approaches, Project management, The business case, Terms of Reference / Project Initiation Document / Project Charter – business objectives, project objectives, scope, constraints (budget, timescale, standards), sponsor (authority), Framework for Requirements Engineering, Actors/ Roles during requirements work.	
Activity: 1. Study the PID for any project and write a summary of the same. Develop an alternate PID for the same and justify why/how the new document is better than the studied one.	

Unit – II	**Contact Hours = 8 Hours**
Types of requirements and Stakeholders : Building the hierarchy through decomposition of requirements, Categories of requirements within the hierarchy, General business requirements, including legal and business policy, Technical policy requirements, Functional requirements, Non-functional requirements, including performance, usability, access, security, archiving, backup and recovery, availability, robustness, Stakeholders, Types of stakeholders and their role and contribution to the requirements engineering process, The Requirements Process . Case Study: Study the Ice Breaker Project (text 2).	
Activity: 1. Identify the stakeholders of the project. Develop the list of stakeholders for any project you identify. Identify their roles and contributions. 2. Build the list of functional and non-functional requirements for any project you identify.	

Unit – III	**Contact Hours = 8 Hours**

Requirements Elicitation: Knowledge types – tacit and non-tacit (explicit), Elements of tacit knowledge that cause problems, Elicitation techniques : Interviews, Workshops, Observation: Formal/informal, Shadowing, Focus groups, Prototyping, Scenarios, Document Analysis **Use of models in Requirements Engineering**: The purpose of modelling requirements, Modelling the business context for the system, Developing a model to represent the system processing requirements, Interpreting a data model.
Activity: 1. Conduct interviews/workshops on the requirements identified for a idea/project. Summarize the outcomes. 2. Develop Prototypes, Scenarios, documents and conduct document analysis for the requirements listed in the above idea/project

Unit – IV	**Contact Hours = 8 Hours**
Requirements Analysis: Organizing requirements, requirements Filters for ensuring well-formed requirements **Requirements Documentation**: The importance of Documentation, Structure of Requirements Document, Requirements catalogue, hierarchy of requirements, Documenting a Requirement-Characteristics of an individual requirement.	
Activity: 1. Prepare a requirements document for any identified idea/project.	

Unit – V	**Contact Hours = 8 Hours**
Requirements Validation: Agreeing the requirements document, Representatives of the review group, Outcomes of a review **Requirements Management**: Dealing with changing requirements, The importance of traceability, Traceability and ownership, Elements of Requirements management, Requirements Engineering support tools.	
Activity: 1. Trace the changes of a requirement identified based on the reviews.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**1**	**1**	**1**	**1**	**1**

Unit No.	**Self-Study Topics**
1	Project Initiation document (PID)
2	Study Of Ice Breaker Project
3	Elicitation technique-Interview
4	Characteristics of an individual requirement
5	Requirements Engineering Support tools

Books	
	Text Books:
1.	Debra Paul, Donald Yeates and James Cadle, Business Analysis, 2nd Edition, BCS Publisher, 2010 and onwards
2.	Suzanne Robertson and James Robertson, "Mastering the Requirements Process", Addison Wesley, 1999 and onwards.
3.	James Cadle, Debbie Paul and Paul Turner, "Business Analysis Techniques: 72 Essential Tools for Success", BCS.
	Reference Books:
1.	Gerald Kotonya and Ian Sommerville, "Requirements Engineering: Processes and Techniques", John Wiley & Sons.
2.	Alistair Cockburn, "Writing Effective Use Cases", Addison-Wesley, 2000 and onwards.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://www.phpkb.com/kb/article/tacit-knowledge-what-is-it-and-how-you-can-promote-it-293.html
2.	https://www.lucidchart.com/pages/uml-use-case-diagram
3.	https://www.knowledgetrain.co.uk/project-management/business-cases/how-to-write-a-business-case
4.	https://openclassrooms.com/en/courses/4544631-learn-the-fundamentals-of-agile-estimation/5371006-discover-the-benefits-of-planning-releases-and-the-pitfalls-of-estimation

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the relevance of requirements engineering in business development	Un	2,6,10,11,12	2,3
2.	Develop a model and analyze the use of a range of requirements elicitation and documentation techniques and the relevance of the techniques to business situations	An	2,6,10,11,12	2,3
3.	Analyze the performance of requirements management process and apply them to manage business requirements.	An	2,6,10,11,12	2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks

Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1		✓				✓				✓	✓	✓		✓	✓
2		✓				✓				✓	✓	✓		✓	✓
3		✓				✓				✓	✓	✓		✓	✓
Tick mark the CO, PO and PSO mapping															

Modern Vehicular Technology (MVT)

Course Code	22EC645	**Course type**	OEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs **Total = 40 Hrs**			**CIE Marks**	100
Flipped Classes content	08 Hours			**SEE Marks**	100

Course Learning Objectives	
1.	To build basics concepts related to vehicle dynamics, transmission characteristics and various transmission techniques for fossil fuel based vehicles, electric vehicles and hybrid vehicles.
2.	To comprehend the basic concepts related to hybrid braking, regenerative braking and their significance in EV and HEV design and performance.
3.	To compare and contrast various energy sources and propulsion systems for EV, HEV, and FCEV.
4.	To analyze various design and control parameters of electric vehicles, hybrid electric vehicles and fuel cell based vehicles under Indian and global scenarios.

Pre-requisites: Fundamentals of engineering physics, basic electrical engineering.

Unit I – Basic Vehicular Dynamics, Propulsion & Power Transmission	**Contact Hours = 8**
General descriptions of vehicle movements, brake performance, fuel economy, basics of SI, CI and natural gas engines, vehicle transmission characteristics for ICEV & EV, manual and automatic transmissions, torque converter, automated manual dual clutch transmission (AMT and DCT)	

Unit II – Electrical Energy Sources and Propulsion Systems	**Contact Hours = 8**
Electrical Energy Sources for EVs – steady and dynamic components of load power, batteries, hydrogen based PEM fuel cell, ultracapacitors, and ultra-high-speed flywheels Propulsion Systems – DC motor, induction motor, brushless DC motors, switched reluctance motors	

Unit III – Electrical and Hybrid EV Basics, & Regenerative Braking	**Contact Hours = 8**
Electric Vehicles – configuration, performance graph, tractive effort in normal driving, energy consumption, concepts of HEV, PHEV, MHEV drivetrains Regenerative Braking – braking energy consumed in urban driving, braking energy and brake power comparison with various parameters, brake system for EV, HEV and FCV	

Unit IV – Series, Parallel and other HEV Architectures	**Contact Hours = 8**
Concept and architecture of hybrid electric drivetrain, series hybrid and parallel hybrid drivetrains, max SoC of PPS control and thermostat control for series hybrid drivetrains, series-parallel (torque-speed) control, GM 2 mode, dual-clutch and Renault mode hybrid transmission	

Unit V – FCHEV Drivetrain Design and Vehicular Energy Management	**Contact Hours = 8**

Fuel Cell Based HEV – PEMFC characteristics, PEMFC sub-systems, configuration of fuel cell hybrid electric drivetrain design, control strategy, design of motor power, PPS and energy capacity for FCHEV Vehicular Power Control Strategy and Energy Management – a generic framework, definition and need, methodologies for optimization, cost function optimization, benefits of energy management

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	--	--	3	3	2

Books and Resources	
	Text Books:
1.	Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles," 3rd Edition, CRC Press, Taylor & Francis Group, 2002.
2.	Chris Mi, M. Abul Masrus, David W. Gao, "Hybrid Electric Vehicles – Principles and Applications with Practical Perspectives," 2nd Edition, Wiley, 2017.
3.	Allen E. Fuhs, "Hybrid Vehicles and the future of Personal Transportation," 2nd Edition, CRC Press, Taylor and Francis Group, NW, 2009.
	Reference Books:
1.	John G. Hayes, G. Abas Goodarzi, "Electric Powertrain – Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles"
	E- Resources:
1.	Fundamentals of Electric Vehicles – Technology and Economics - IITM NOC https://www.youtube.com/watch?v=UgtjRob5qMg&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=1 **by Prof. Ashok Jhunjhunwala, IIT Madras**
2.	How Do Electric Vehicles Work? Working Principles of EV-Certified EV Crash Course, 3 Hour video YouTube Link - https://www.youtube.com/watch?v=qIfjibyt6pY

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Offline Quizzes
3.	Flipped Classes	3.	Open Assignments
4.	Online Classes	4.	Course Seminar
5.	Industry Visit	5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	**explain** the specific requirements of EV, HEV and FCV for a cleaner environment and **compare** it with pollution caused by ICEV	Un	1,3,6, 7,8,12	1,3
2.	**identify** the importance of various propulsion systems and energy sources & also **justify** the need of infrastructure development for fuel cell based vehicles (FCV) in India	Un	1,2,6	1

3.	**develop** sound knowledge related to regenerative braking, hybrid braking & hybrid propulsion systems for modern day vehicles	Ap	1,3,6, 7,8,12	1,3
4.	**distinguish** among the critical design and control parameters for EV, HEV and FCV	An	1,2,3, 5,6,7,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Aassignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of at least 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE+SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B, and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 question choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 Questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	--	✓	--	--	✓	✓	✓	--	--	--	✓	✓	--	✓
2	✓	✓	--	--	--	✓	--	--	--	--	--	--	✓	--	--
3	✓	--	✓	--	--	✓	✓	✓	--	--	--	✓	✓	--	✓
4	✓	✓	✓	--	✓	✓	✓	--	--	--	--	✓	✓	✓	✓

CYBER SHIELD: HANDS-ON SECURITY PRACTICES

Course Code	22EC646	**Course type**	**OEC Integrated Project based**	**Credits L-T-P**	2 – 0 – 1
Hours/week: L-T-P	2 – 0 – 2			**Total credits**	3
Total Contact Hours	L = 20 Hrs, T = 0 Hrs, P = 20 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	NIL			**SEE Marks**	100

Course learning objectives	
1.	To understand the basics of cybersecurity and get familiar with cybersecurity analysis tools
2.	To acquire knowledge regarding types of security threats, attacks and countermeasures
3.	To explore secure coding practices

Required Knowledge of: Basic understanding of internet

Unit – I	**Contact Hours = 4 Hours**

Cybersecurity System Fundamentals

Introduction to Digital data, its types and information, Introduction to information system, Introduction to management information systems (MIS) and its functions. Introduction to Data Centre and its infrastructure

Introduction to virtualization, its benefits and virtual machines

Components of Virtual Machines, its hardware and its benefits, Application and Desktop Virtualization and their techniques

Introduction to Cyber Security

CIA Triad-3 pillars of information security architecture, CIA components and its importance, Cyber security threats and best practices, Access controls and its types, Types of Reconnaissance, Types of Cyber Attack, Vulnerability Assessment and its features, Concept and types of Scanning Methodology, Penetration Tests

Unit – II	**Contact Hours = 4 Hours**

Network Security Threats and countermeasures

Network Security Devices, Types of Network Securities, Network Access Control, Application Security, Firewalls and its types, virtual private network, Tunnelling protocol and types IDS, IPS and their Types, Introduction to Web Application Vulnerabilities

Basic Practices of Web Application Security

Common Cyberattacks on Web Applications, Mobile Application Vulnerabilities, Mobile Application Security, Fundamentals of Mobile Device Management, Overview of Mobile Device Management

Unit – III	**Contact Hours = 4 Hours**

Firewall and its types

Types of Firewalls and its benefits, Packet Filtering Firewall, Application Firewall, Inspection Techniques, Stateful and Stateless Application, Internet protocol, TCP Header, Client Server Model, DNS and DHCP, SSL and TSL, VPN and how it protects your IP address and privacy

Network Analysis

Information and view specific packets being sent and received on the network, Security Configuration Checklist, Monitoring Network Bandwidth, Network Analyzers, Wireshark and its use cases

Case Study: NMAP tool

Unit – IV	Contact Hours = 4 Hours
Cryptography Cryptography and Cryptanalysis, Types of cryptography, Symmetric encryption, Asymmetric encryption, Understanding digital certificates and signatures, introduction to signatures, introduction to digital certificates, introduction to cryptographic attacks, types of cryptographic attacks, Traditional cryptographic attacks, Counter measures to cryptographic attacks Case Study: Cryptool	

Unit –V	Contact Hours = 4 Hours
Web Server & Application Security Concept and overview of 3 tier Architecture, Web Application Basics, Working of Domain Name System (DNS), Working of DNS and its vulnerabilities, Web Server Vulnerabilities, Web Application Security, Web Application Attacks, Working of HTTP, Configuring Chrome to work with Burp, HTTP Request Methods, HTTP Status Messages, HTTP – Responses. **Secure Coding Techniques** OWASP Secure Coding Practices, Quick Reference Guide, WPScan and its uses Case Study: Burp Suite and its tools	

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**2**	1. Virtual lab environment setup for cybersecurity 2. Introduction to Kali Linux and its significance in cybersecurity
2	**2**	1. Fundamentals of Network Security protocols, firewalls, and encryption 2. Introduction to Penetration Testing: Conducting a basic penetration test on a vulnerable system
3	**2**	1. Conduction of network scanning and host enumeration using tools like Nmap 2. Network Scanning and Host Discovery with Nmap
4	**2**	1. Data Encryption and decryption the data using RSA and secure key exchange using Diffie-Hellman Key exchange protocol. 2. Securing email communication with GnuPG
5	**2**	1. Creating strong passwords and managing them 2. Testing Password Strength with John-the-riper and Hashcat

Unit No.	Self-Study Topics
1	Case study: Green Data Centre
2	Case study: Google Data Centre
3	Internet Control Message Protocol
4	Hash Cryptography
5	Case study: Web Application Vulnerability Scanning Tools

Books	
	Text Books:
1.	William Stallings, Cryptography and Network Security, Pearson 6th edition, 2005 onwards
2.	Michael E. and Herbart J.: Principles of Information Security, 2nd Edition 2005onwards

3.	Michael Gregg, Omar Santos, Certified Ethical Hacker (CEH) Version 10 Cert Guide,Pearson IT Certification, 3rd Edition, 2019 onwards
4.	Shankar Kambhampaty, Infrastructure Architecture Essentials for Data Centerand Cloud, 2022 onwards (ISBN 979-8786300469)
	Reference Books:
1.	Matt Walker, CEH Certified Ethical Hacker All-in-One Exam Guide, FourthEdition,McGraw-Hill, 4th Edition, 2019 onwards
2.	Wes Noonan, Firewall-Fundamentals, Cisco-Press, 1 st Edition, 2006 onwards
3.	Angela Orebaugh, Nmap in the Enterprise: Your Guide to Network Scanning, Syngress, 2008 onwards
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	
2.	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests- Theory & Lab based
2.	PPT and Videos	2.	Project phase 1 & 2
3.	Practice session/Demonstrations in Labs	3.	SEE- Project evaluation
		4.	SEE- Solving an Open ended problem

Course Outcome (COs)

Learning Levels:

Re - Remember, Un - Understand, Ap - Apply, An - Analysis, Ev - Evaluate, Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Examine the vulnerabilities at different parts of the networks and deign secured services	L3	1,2,3, 4, 5, 8,9,10,11,12	2,3
2.	Analyze various types of attacks and compare the performance of various countermeasure tools.	L4	2, 3, 4, 5, 6,8,9,10,11,12	2,3
3.	To evaluate the secure systems in various web applications	L5	2, 4, 5, 6,8,9,10,11,12	2,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
Theory IA test should be of one-hour duration. Lab IA test should be of two/three-hour duration. Project batch will ideally consist of 2 students (maximum of 3).					

Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. Submitting Project report is compulsory.
Eligibility for SEE: 1. 40% and above (16 marks and above) in theory component 2. 40% and above (24 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (20 marks write-up + 20 marks algorithm/flowchart + 10 marks execution)	50 marks	100 marks
	Project evaluation a. Initial write up stating the objectives, methodology and the outcome b. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project. c. Viva-voce	10 marks 30 marks 10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓
2		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
3		✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
Tick mark the CO, PO and PSO mapping 2, 4, 5, 6,8,9,10,11,12															

C Programming for Industry using Linux

Course Code	**22EC647**	**Course type**	**OEC**	**Credits L-T-P**	2– 0 – 1
Hours/week: L - T- P	2 – 0 – 2			**Total credits**	3
Total Contact Hours	L = 20 Hrs; T = 0 Hrs; P = 20 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	A practical hands-on approach to teaching C with examples on where it is used.
2.	Behind the scenes peek at how a C program is stored in memory and when in execution.
3.	Introduce the students to Linux command line environment.
2.	Introduce C concepts essential for driver writing and embedded programming.

Required Knowledge of: Basic C programming constructs and steps to write, compile and execute a program.

Unit – I (L – 1, P - 7)	**Contact Hours = 8 Hours**
Linux environment: Linux command line and gvim editor. **Revisit to C concepts:** Basic C data types, basic decision control and looping statements in C, Arrays. **Coding standards:** what is expected in terms of coding standards and why it is important to know.	
Self-Study: Assignments and Quiz on Linux Commands and gvim editor Practical Assignments on Basic C concepts to be executed on Linux command line	

Unit – II (L – 8)	**Contact Hours = 8 Hours**
C to binary conversion: Introduction to computer systems, compilation process & understanding the output of the compilation process. **Data interpretation:** How the different data types get stored in memory. **Pointers:** de-mystifying pointers, initializing (static versus dynamic), pointer arithmetic. **Arrays:** Relationship between arrays, pointers, and multidimensional arrays in C. **Strings:** Introduction, example and usage of string library functions. String constants. **C declarations**: understanding C declarations.	

Unit – III (P – 4, L - 4)	**Contact Hours = 8 Hours**
Debugging: Debugging using gdb, Command line arguments, **Functions:** Introduction, communication between functions, Arrays as arguments to functions.	
Assignments: Solving assignments related to Unit II concepts using gdb (Writing a C program to add two numbers using command line arguments using the online resources)	

Unit – IV (L – 3, P – 5)	**Contact Hours = 8 Hours**

C pre-processor: The different preprocessor constructs and conditional compilation. **Bit wise operations:** Understanding bit wise operators, their usage and applications. **User defined data types:** Enumerated type**s, s**tructures, unions and bit fields. **Typedefs**: Changing the names of data types and why is this required.
Assignments: Apply the concepts learned in unit III and IV through assignments.

Unit – V (L – 4, P – 4)	**Contact Hours = 8 Hours**
Multi-File Programming and Advanced C Concepts: Concept of multi-file programming in C, explores some important but less-commonly used keywords, revisits compilation and linking in a multi-file context, and delves into variable scope.	
Assignments: Apply these concepts through assignments.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

List of Experiments

Unit No.	**No. of Assignments**	**Topic(s) related to Experiment**
1	1	Install Linux Ubuntu 22.04 virtual box installed on their lab and personal systems.
1	1	Quiz on Linux
1	5	1) Print first 100 prime numbers 2) Find when the population of CurvedLand exceeds FlatLand population. 3) Range of numbers that can be stored in different data types 4) Diamond pattern generation 5) Insert and delete element from array.
2	2	1) Word count 2) Line fold 3) Sorting names
3	2	1) Find the hexadecimal equivalent, factorial or reverse digits of a number provided on command line. 2) Concatenate strings
4	1	1) Invert n bits from position p in number x 2) Get n right most bits from y and insert it at position p in number x 3) Calculate the average of Maths and Science marks of a class of students.
5	1	Implementation of main and my_strlen functions in separate files

Unit No.	**Self-Study Topics**
1	Linux operating systems
2	Bash terminal
3	Vim tutorial

4	Command line arguments to C program

Books	
	Text/Reference Books:
1.	Brian W. Kernighan and Dennis M. Ritchie, The 'C' Programming Language, Prentice Hall of India. (PDF version available)
2.	Programming with C, Schaum series book for plenty of practice programs
3.	Coding standards.pdf
	E-resources:
1.	Introduction to Linux operating system. Link: https://www.youtube.com/watch?v=V1y-mbWM3B8
2.	Beginner's guide to the bash terminal. Link: https://www.youtube.com/watch?v=V1y-mbWM3B8
3	Vim tutorial link: https://www.youtube.com/watch?v=IiwGbcd8S7I

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Students will be able to **identify and describe** basic C concepts, including data types, control flow statements, arrays, Linux commands, and gvim editor functionalities.	Re	1,2,3,5,12	1
2.	Students will be able to **explain** the compilation process in C, interpret data storage based on data types, and demonstrate an understanding of the relationship between pointers, arrays, and multidimensional arrays.	Un	1,2,3,5,12	1
3.	Students will be able to **apply** debugging techniques using gdb to identify and fix errors in C programs. Additionally, they will be able to **create** C functions that utilize command-line arguments for user input.	Ap	1,2,3,5,9,12	1
4.	Students will be able to **analyze** the effects of bitwise operations on data, **compare and contrast** different user-defined data types (enumerated types, structures, unions,	An	1,2,3,5,9,12	1

	bit fields), and **explain** the purpose of typedefs in C programming.			

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab exam will be conducted at the end of the semester.

THEORY (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
Theory IA test should be of one-hour duration. Lab IA test should be of two/three-hour duration. Project batch will ideally consist of 2 students (maximum of 3). Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. Submitting Project report is compulsory.					
Eligibility for SEE: 1. 40% and above (16 marks and above) in theory component 2. 40% and above (24 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (20 marks write-up + 20 marks algorithm/flowchart + 10 marks execution)	50 marks	100 marks
	Project evaluation d. Initial write up stating the objectives, methodology and the outcome e. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project. f. Viva-voce	10 marks 30 marks 10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
1	✓	✓	✓		✓							✓	✓		
2	✓	✓	✓		✓							✓	✓		

3	✓	✓	✓		✓							✓	✓		
Use tick mark(✓)															

Communication Networks

Course Code	22EC71	Course type	IPCC	Credits L-T-P	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To familiarize with the working model of OSI and TCP/IP protocol suite, and to discuss reliable data communication methods
2.	To explain the working of networking resources and channel access techniques
3.	To compare the different methods of switching and to understand the challenges in IP addressing.
4.	To understand the significance of TCP and UDP in computer communications networks and investigate the network performance.

Required Knowledge of: Principles of Communication system

Unit – I	Contact Hours = 8 Hours
Data Communications: Components, Representations, Data Flow, Networks: Physical Structures, Network Types: Switching, Transmission time, Latency, throughput, delay bandwidth product, Jitter. TCP/IP Protocol Suite: Layered Architecture, Description of layers, Addressing. The OSI Model: OSI Versus TCP/IP. Case Study: Protocols and Standards	

Unit – II	Contact Hours = 8 Hours
Data Link Control: LLC layer: Framing, Flow and Error Control, Noiseless Channels and Noisy Channels, HDLC. Data Link Layer Protocols: Reliable Transmission, Simplex Protocol, Stop and Wait protocol, Sliding Window, selective repeat, Piggybacking. Case Study: Different error control implementation schemes in LLC layer.	

Unit – III	Contact Hours = 8 Hours
Media Access Control: Random Access, ALOHA, slotted aloha, CSMA, CSMA/CD, CSMA/CA. Controlled Access: Reservation, Polling, Token Passing. ATM networks, BISDN reference model, ATM layer. Virtual LANs: Membership, Configuration, Communication between Switches, Advantages. Case Study: Demonstration of LAN configuration and it's working	

Unit – IV	Contact Hours = 8 Hours
Network Layer services: Packetizing, Switching and forwarding, Datagram, Virtual Circuit Switching, Source Routing. IPV4 Addresses: Classful Addressing, classless addressing, DHCP, Network Address Resolution and Border Gateway Protocols (BGP), Embedding IPv4 Addresses in IPv6 For Transition. Case Study: Simulating of LAN and study of packet transfer using packet tracer tool.	

Unit – V	Contact Hours = 8 Hours
Transport Layer: Introduction, Transport Layer Services, Connectionless and Connection oriented Protocols. User Datagram Protocol: User Datagram, UDP Services, UDP Applications, TCP congestion control. Application Layer: SMTP, MIME, IMAP, HTTP, SNMP, Real-time Transport Protocol (RTP) and Applications of blockchain in computer networks. Case Study: With help of research papers document the various network working scenarios in which TCP/UDP are preferable	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Study of networking devices, NIC card and cable crimping process needed for network deployment
1	1	Design a local area network, configure the nodes, switches and illustrate the data flow using packet tracer tool.
2	1	Simulate the different network topologies using CISCO packet tracer.
2	1	Simulate Routing Information Protocol (RIP) algorithm using CISCO packet tracer.
3	1	Configure the server to implement DHCP and ARP services.
3	1	Configure and simulate the network to implement SMTP services
4	1	Design and implement smart garden system using remote terminal and wireless links
4	1	Design and implement virtual LAN
5	1	Configure and simulate to study the functionality and working of a Border Gateway Protocol and virtual LAN
5	1	Simulation of Wi-Fi using virtual Lab.

Unit No.	Self-Study Topics
1	Numerical on Performance parameters
2	Numerical on LLC layer protocols.
4	Numerical on IP addressing

Books	
	Text Books:
1.	Behrouz A Forouzan, “Data Communication and Networking”, Tata McGraw-Hill publishing Company Limited, Indian Edition, 2006 and onwards.
2.	Alberto Leon Garcia, “Communication Networks”, McGraw-Hill, 2010

	Reference Books:
1.	Larry L. Peterson and Bruce S. Devie, Computer Networks, Morgan Kaufmann Publications, 5thEdition and onwards.
2.	William Stallings, "Data and Computer Communications", Prentice-Hall, 2007
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Course Title: Computer Communications Specialization https://www.coursera.org/specializations/computer-communications#courses

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Compare the various data flow control methods with respect to general data network communication. Compare and contrast the OSI model and TCP/IP architecture suite	Understand	1,2	1
2.	Analyze the relevance of networking components and methods of channel access techniques	Apply	2,3,5	1
3.	Compare and analyze the relevance of Transport Control Protocol and User datagram protocol to design congestion free network.	Analysis	1,2,5,10,12	1
4.	Design and analyze the network addresses using the knowledge of data switching and IPV4 addressing.	Evaluate	2,3,5,12	1

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)		LAB (40 marks)		Total
IA test 1	IA test 2	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive				
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks				
Lab test: (Batchwise with 15 students/batch)				

1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 15 marks 5. Viva voce: 10 marks
Eligibility for SEE: 1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE** 2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.** 3. Lab test is COMPULSORY 4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.** 5. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
Un	✓	✓	✓										✓		
Ap			✓										✓		
An	✓	✓	✓			✓			✓				✓		
Ev										✓	✓	✓	✓		
Use tick mark(✓)															

Microwave and Antenna Engineering

Course Code	**22EC72**	**Course type**	**IPCC**	**Credits L-T-P**	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the fundamental concepts of microwave propagation circuits and devices.
2.	To analyze microwave propagation circuits and devices on the basis of available data.
3.	To design microwave propagation circuits and devices for a specific application.

Required Knowledge of: Electromagnetic Field Theory, Antenna Basics

Unit – I	**Contact Hours = 8 Hours**
Microwave Transmission Lines: Microwave Frequencies and band designations (IEEE microwave frequency bands), Microwave devices, Microwave Systems, Transmission Line equations and solutions **(quantitative analysis only)**, Reflection Coefficient and Transmission Coefficient, Standing Wave and Standing Wave Ratio, Smith Chart, Single Stub matching, double stub matching.	

Unit – II	**Contact Hours = 8 Hours**
Microwave Network theory: S matrix representation of Multi-Port Networks, Properties of S matrix, S parameters of a two-port network with mismatched load. Microwave Passive Devices: Coaxial Connectors and Adapters, Attenuators, Phase Shifters, Waveguide Tees: E-plane, H-plane and Magic Tee, Isolators, Circulators, and Directional couplers.	

Unit – III	**Contact Hours = 8 Hours**
Microwave Tube Devices: - Introduction; Conventional Vacuum Triode, Tetrode and Pentode; Klystrons, Multicavity Klystrons Amplifiers, Reflex Klystrons; Magnetron: Introduction, Magnetron Oscillators. Microwave Active Devices: Transferred Electron Device (TED), Gunn Diode, RWH Theory, Modes of Gunn Operation; Avalanche Transit Time Devices: READ Diode.	

Unit – IV	**Contact Hours = 8 Hours**
Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of $n - Isotropic$ point sources of equal Amplitude and Spacing	

Unit – V	**Contact Hours = 8 Hours**
Loop, Horn and Helical Antenna: The Loop Antenna General Case, Far-field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Horn antennas, Rectangular Horn Antennas. Helical Antenna: Introduction, Helical Geometry, modes of Helix operation.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	2	1. Impedance matching using Lumped parameters. 2. Impedance matching using distributed parameters.
2	4	1. Develop S-matrix of E plane tee. 2. Develop S-matrix H E plane tee. 3. Develop S-matrix Magic tee. 4. Develop S-matrix Directional Coupler.
3	2	1. Guide wavelength, VSWR, frequency measurement for microwave source. 2. Gunn Diode Characteristics.
4	1	1. Yagi-Uda antenna radiation Characteristics
5	2	1. Horn antenna radiation Characteristics.

Unit No.	Self-Study Topics
1	Applications of Smith chart.
2	Applications of Magic Tee.
3	Oscillators and Amplifiers; Semiconductor device physics basics; IMPATT, TRAPPAT, BARITT.
4	Review of Antenna Basic Parameters; EM fields of: - short dipole antenna, (λ/2) antenna.
5	Applications of Loop, Horn and Helical Antenna.

Books	
	Text Books:
1.	John D. Krauss, "AntennasandWavePropagation",4thEdition, McGraw-Hill International, 2010 and onwards.
2.	Samuel Liao, "Microwave Devices and circuits", Pearson Education.
	Reference Books:
1.	Annapurna Das and Sisir K Das, "Microwave Engineering", TMH Publication, 2nd Edition, 2010 and onwards.
2.	Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 6th Edition, 2014 and onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Dr. Ratnajit Bhattacharjee, IIT Guwahati, "Microwave Engineering", https://nptel.ac.in/courses/108103141
2	Dr. Amitabha Bhattacharya, IIT Kharagpur, "Analysis and Design Principles of Microwave Antennas", https://nptel.ac.in/courses/108105114

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Understand the requirement of microwave devices and circuit for various applications	Un	1,2,10,12	1, 2
2.	Analyze the parameters of the various components for the given criteria.	An	1,2,3,4,5,9,10,11,12	1, 2
3.	Design and develop circuits for the specific requirements of applications.	Ev	1,2,3,4,5,9,10,11,12	1, 2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)		LAB (40 marks)		Total
IA test 1	IA test 2	Conduction	Lab test	
30 marks	30 marks	10 marks	30 marks	100 marks

IA Test:
1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:
1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks

Lab test: (Batchwise with 15 students/batch)
1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 15 marks
5. Viva voce: 10 marks

Eligibility for SEE:
1. **Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests. Lack of minimum score in IA test will make the student Not Eligible for SEE**
2. **Student should score minimum 40% of 30 marks (i.e. 12 marks) in Lab test & should score 40% of 40 marks (i.e. 16 marks) in Lab component.**
3. Lab test is COMPULSORY
4. **Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.**
5. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													CO-PSO Mapping (planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓								✓		✓	✓	✓	
2	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
3	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
Use tick mark (✓)															

Wireless Communication

Course Code	**22EC73**	**Course type**	**PCC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 00 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand cellular system components, modulation and multiple-access techniques used in wireless communication
2.	To analyze wireless channel characteristics in the design of channel propagation models
3.	To apply emerging wireless technologies and their functionalities in mobile communication

Pre-requisites: Digital communication

Unit – I	**Contact Hours = 8 Hours**
Tele-traffic Engineering Fundamentals: Introduction, Service level, Traffic usage, Traffic measurement units, Call Capacity, Traffic types, Blocking formulas- Erlang B, Erlang C, Poison's , Binomial formula.	

Unit – II	**Contact Hours = 8 Hours**
Fundamentals of cellular communications: Introduction, Cellular systems, Hexagonal cell geometry, Co-channel interference ratio and its reduction, n-cell reuse pattern, Cell splitting, Adjacent channel interference, Segmentation, typical wireless cellular network components, numbering schemes, mobility and handoff management.	

Unit – III	**Contact Hours = 8 Hours**
Transmission techniques: **Modulation techniques:** Introduction, QPSK, OQPSK, M-PSK, QAM, M-ary FSK, GMSK , GFSK, Synchronization, Equalization. **Multiple Access Techniques:** TDMA, FDMA, CDMA, CSMA, MIMO, OFDM.	

Unit – IV	**Contact Hours = 8 Hours**
Radio Propagation Path-Loss Models: Introduction, Free-space attenuation, Attenuation over reflecting surface, Effect of Earth's curvature, Radio wave propagation, Wireless channel characteristics, Signal fading statistics, Level crossing rate and average fade duration, Fade margin, Link margin, Outdoor and indoor propagation models.	

Unit – V	Contact Hours = 8 Hours
Applications of wireless technologies: Bluetooth, RFID, Zigbee, Near Field Communication (NFC), Wi-Fi, Wi-MAX, Wireless Access Point (WAP), Software Defined Radio/Cognitive Radio.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Vijay K. Garg, Wireless Communications and Networking, Elsevier, 2nd Edition, 2018.
2.	Gary J. Mullet, Introduction to wireless telecommunications systems and networks, Cengage Learning, 2016.
	Reference Books:
1.	Jochen Schiller, Mobile Communications, Pearson Education, 2nd Ed, 2014.
2.	Theodore S. Rappaport, Wireless Communications- Principles and Practice, Pearson, 2nd Ed, 2016.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	Wireless Communication, Prof. Ranjan Bose, IIT Delhi https://nptel.ac.in/courses/117102062
2.	Fundamentals of MIMO Wireless Communication, Prof. Suvra Sekhar Das, IIT Kharagpur https://nptel.ac.in/courses/117105132

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Assignments (OBA)
		4.	Course Activity
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the fundamental concepts of wireless mobile communication for cellular component system	Un	1, 2, 6	1
2.	**Apply** suitable modulation and multiple access techniques for wireless and mobile communication.	Ap	1, 2, 5	1, 2

3.	**Analyze** the performance of wireless communication channel/medium for a given indoor and outdoor propagation scenario.	An	1, 5	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
1	✓	✓	✓			✓				✓		✓	✓		✓
2	✓	✓	✓			✓				✓		✓	✓		✓
3	✓	✓	✓			✓				✓		✓	✓		✓

Indian Knowledge System

Course Code	22AECEC77	Course type	AEC	Credits L-T-P	1– 0 – 0
Hours/week: L – T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 15Hrs; T = 0 Hrs; P =0 Hrs Total = 15 Hrs			CIE Marks	100
Flipped Classes content	03 Hours			SEE Marks	--

Course learning objectives	
1.	To understand the importance of ancient knowledge to a society and familiarize with vedas and vedangas
2.	To understand the concepts of science and technology in ancient India

Pre-requisites: Nil

Unit – I	Contact Hours = 5 Hours
Importance of ancient knowledge and IKS. IKS corpus – a classification framework, history and unique aspects of IKS. Introduction to vedas and vedangas, vedic life. Indian philosophical systems – development and unique features, vedic schools of philosophy. Panchatantra – puranas and itihasa as a source of wisdom.	

Unit – II	Contact Hours = 5 Hours
Foundational concepts for science and technology – importance & role of Sanskrit in Natural language processing, stages of speech in Sanskrit vocabulary, number system in India, salient features of numerical system- measurement for time, distance & weight.	

Unit – III	Contact Hours = 5 Hours
Science, Engineering and Technology in IKS – unique aspects of Indian Mathematics and astronomy, functions in Mathematics, historical development of astronomy, elements of Indian calendar. The rise and fall of great Indian technology, mining, metal working, alloys in India Irrigation practices and architecture in India	

Flipped Classroom Details

Unit No.	I	II	III
No. for Flipped Classroom Sessions	1	1	1

Books	
	Text Books:
1.	B. Mahadevan, V. R. Bhat and R. N. Nagendra Pavana, “Introduction to Indian Knowledge system - Concepts and Applications”, PHI, 2023

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Assignments (OA)
4.	Online classes	4.	

Course Outcomes (Cos) **Learning Levels:** **Re – Remember; Un – Understand; Ap – Apply; An – Analysis; Ev – Evaluate; Cr – Create**				
At the end of the course, the student will be able to:		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the importance of ancient knowledge to a society and familiarize with vedas and vedangas	**Un**	**6,7**	**1**
2.	**Understand** the fundamental concepts of science and technology in ancient India	**Un**	**6,7**	**1**

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two Assignments	Case study/Activity	Total Marks
Marks	30+30 = 60	10+10 =20	20	100

- Writing 2 IA tests are compulsory.
-Student should score minimum 40% of 100 marks to pass the course.

CO-PO Mapping (Planned) [tick mark relevant ones]													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1						✓	✓						✓		
2						✓	✓						✓		

Advanced Wireless Communication Lab

Course Code	**22ECL78**	**Course type**	**PCCL**	**Credits L-T-P**	0 - 0 - 1
Hours/week: L - T- P	0 - 0 - 2			**Total credits**	1
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 20 Hrs Total = 20 Hrs			**CIE Marks**	50
Flipped Classes content				**SEE Marks**	50

Course learning objectives	
1.	To understand working principle data transmission and reception using modulation techniques
2.	To analyze the working principle of multiple access methods
3.	To assess the performance of antenna design for advanced wireless technology

Required Knowledge of :

Lab Experiment – I	**Contact Hours = 2 Hours**
Tone generation and loopback with Time, Frequency and waterfall plot.	
Lab Experiment – 2	**Contact Hours = 2 Hours**
Transmission and reception of data using GMSK modulation using RF link	
Lab Experiment – 3	**Contact Hours = 2 Hours**
Transmission and reception of data using GFSK modulation using RF link	
Lab Experiment – 4	**Contact Hours = 2 Hours**
OFDM Generation and reception over RF link.	
Lab Experiment – 5	**Contact Hours = 2 Hours**
CDMA transmission and reception over RF link	
Lab Experiment – 6	**Contact Hours = 2 Hours**
Set up SDR as a FM transmitter and receiver of stored signal.	
Lab Experiment – 7	**Contact Hours = 2 Hours**
QPSK Generation with channel model a) Reception of QPSK with frequency offset and viewing constellation point b) Reception of QPSK with phase offset and viewing constellation point c) Reception of QPSK with timing offset and viewing Constellation point	
Lab Experiment – 8	**Contact Hours = 2 Hours**
To design and analyse QAM	

Lab Experiment – 9	**Contact Hours = 2 Hours**
To design and Implementation of MIMO(2x2)	
Lab Experiment – 10	**Contact Hours = 2 Hours**
Video Streaming over DVB link	

Books	
	Text Books:
1.	Vijay K. Garg, Wireless Communications and Networking, Elsevier, 2nd Edition, 2018.
2.	Gary J. Mullet, Introduction to wireless telecommunications systems and networks, Cengage Learning, 2016.
3.	Jochen Schiller, Mobile Communications, Pearson Education, 2nd Ed, 2014.
4.	Theodore S. Rappaport, Wireless Communications- Principles and Practice, Pearson, 2nd Ed, 2016.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	Wireless Communication, By Prof. Ranjan Bose, IIT Delhi https://nptel.ac.in/courses/117102062 (
2.	Fundamentals of MIMO Wireless Communication, Prof. Suvra Sekhar Das, IIT Kharagpur https://nptel.ac.in/courses/117105132

Course delivery methods		**Assessment methods**	
1.	Practice session/Demonstrations in Labs	1.	Conduction of Experiments
2.	Virtual Labs (if present)	2.	Journal writing
3.	Chalk and Talk	3.	Lab project/ Open ended experiment
4.		4.	Lab Test
5.		8.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** working principles of wireless data transmission using modulation techniques.	Un	1, 2, 4, 5, 9, 12	1
2.	Assess the performance of wireless multiple access techniques for RF communication	Ap	1, 2, 4, 5, 9, 12	1, 2
3.	**Analyze** design consideration for antenna and its performance in advanced wireless technology	An	1, 2, 4, 5, 9, 12	1

Scheme of Continuous Internal Evaluation (CIE):

Conduction of experiments & viva-voce	Journal	Lab project/ Open ended expts	Lab Test	Total
20 marks	5 marks	10 marks	15	50 marks

Conduct of Lab:

10. Conduction of the experiment: 15 marks + Viva voce: 5 marks
11. Calculations, results, graph, conclusion and Outcome recorded in Journal: 5 marks
12. Lab project/ Open ended expt: 10 marks
3. Lab Test: 15 marks

Eligibility for SEE:

4. 40% and above (20 marks and above)
2. **Lab test is COMPULSORY**

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 2/3 hours duration.		
2.	**Minimum marks required in SEE to pass:** Score should be ≥35% , however overall score of CIE+SEE should be ≥40%.		
2.	One or Two experiments to be conducted.		
3.	Minimum marks required in SEE to pass: 20 out of 50		
4.	Initial write up	10 marks	50 marks
	Conduct of experiments, results and conclusion	20 marks	
	One mark question	10 marks	
	Viva- voce	10 marks	
5.	Viva-voce shall be conducted for individual student and not in a group.		

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓		✓	✓				✓		✓	✓		✓
2	✓	✓	✓		✓	✓				✓		✓	✓		✓
3	✓	✓	✓		✓	✓				✓		✓	✓		✓
Tick mark the CO, PO and PSO mapping															

Advanced VLSI Design

Course Code	**22EC74A**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To introduce integrated circuits manufacturing techniques and design methods.
2.	To comprehend and apply VLSI design techniques to data path subsystems and memory units.
3.	To understand the performance parameters design strategies and factors considered minimize the implementation cost.

Pre-requisites: CMOS VLSI Design, MOSFET ideal and non-ideal characteristics

Unit – I	**Contact Hours = 8 Hours**
Digital Systems and VLSI: Importance of Integrated Circuits Design, Integrated Circuit, Manufacturing, CMOS Technology, Integrated Circuit Design Techniques, Hierarchical design, Design abstraction, IP-Based Design. **Case study:** IP Components	

Unit – II	**Contact Hours = 8 Hours**
Datapath Subsystems: Introduction, Addition/Subtraction, Single-Bit Addition, Carry-Propagate Addition, Subtraction, Multiple-Input Addition, Flagged Prefix Adders, Counters, Binary Counters, Linear-Feedback Shift Registers, Barrel Shifter, Multiplication, Unsigned Array Multiplication. **Case study:** Implementation of Column Addition, Fused Multiply-Add using cadence tool.	

Unit – III	**Contact Hours = 8 Hours**
Array subsystems: introduction, SRAM cell, 6T SRAM cell, Area, Delay, and Power of RAMs and Register Files, Dynamic RAMs (DRAMs), Subarray Architectures, Column Circuitry, 3T, 4T DRAM cell, Read Only Memory, Flash memory. **Case study:** Simulation of memory cells using cadence tool	

Unit – IV	**Contact Hours = 8 Hours**
Design and Economics: Introduction, Structured Design Strategies, A Software Radio—A System Example, Hierarchy, Regularity, Modularity Locality, ASIC design flow, economics, Design reuse, Data sheets and documentation.	

Unit –V	**Contact Hours = 8 Hours**

DESIGN FOR MANUFACTURABILITY: Introduction, Process Variations, Basic Concepts and Definitions Design of Experiments and Performance Modeling, Parametric Yield Estimation, Parametric Yield Maximization, Worst-Case Analysis, Performance Variability Minimization.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	2	2	1	1

Books	
	Text Books:
1.	Wayne Wolfe, "Modern VLSI Design, System-On-Chip Design", Prentice Hall, 2002 Onwards
2.	Neil Weste, and David Harris, "CMOS VLSI Design, A Circuits and System Perspective", 4th Edition; Pearson Education, India.
3.	Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits, Analysis and Design", McGraw Hill Publications.
	Reference Books:
1.	Douglas Pucknell, and Kamran Eshraghian, "Basic VLSI Design", PHI Publications IndiPvt. Ltd.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to.				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand integrated circuits manufacturing techniques and design methods	Un	1,2,12	1
2.	Apply modeling methods to understand the performance parameters of integrated circuits.	An	1,2,5,11,12	1
3.	Apply VLSI design techniques to design data path subsystems and analyze the speed of memory units.	Ap	1,2,11,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓										✓	✓		
2	✓	✓			✓						✓	✓	✓		
3	✓	✓									✓	✓	✓		
Use tick mark(✓)															

RF and Microwave Integrated Circuits

Course Code	22EC74B	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To study the theoretical foundations, concepts and properties of RF microwave circuits/components.
2.	To determine various parameters for evaluating the performance for RF/microwave circuits/components.
3.	To learn the development of RF/microwave circuits/component frontend functional blocks.

Pre-requisites : Engineering Mathematics; Electromagnetic Theory and Antenna Engineering; Microwave and Radar Engineering

Unit – I	**Contact Hours = 8 Hours**
Wave propagation in networks: Introduction, Reasons for using RF/Microwaves, Applications, RF waves, RF and Microwave circuit design, Introduction to components basics, Analysis of simple circuit phasor domain, RF impedance matching, Properties of waves, transmission media, Micro strip lines, High frequency parameters, Formulation of S-parameters, Properties, transmission matrix, Generalized S-parameters.	

Unit – II	Contact Hours = 8 Hours
Passive circuit design: Introduction, Design of matching networks, Matching using lumped and distributed elements	

Unit – III	Contact Hours = 8 Hours
Basic consideration in active networks and design of amplifiers, oscillators and detector: Stability consideration, gain consideration, Noise consideration. Linear and nonlinear design: Introduction, Types of amplifier, Design of different types of amplifiers, Multistage small signal amplifiers, Design of transistor oscillators, Detector losses, detector design	

Unit – IV	Contact Hours = 8 Hours
Mixers, Phase shifters and RF and Microwave Control Circuit design: Mixer types, Conversion loss for SSB mixers, One diode mixer, Phase shifters, Digital phase shifters, Semiconductor phase shifters.	

Unit – V	Contact Hours = 8 Hours
RF and microwave IC design: MICs, MIC materials, Types of MICs, Hybrid verses monolithic ICs, Chip materials.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	0	0	0	0

Books	
	Text Books:
1.	Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education edition, 2004.
2.	Reinhold Ludwig, and Pavel Bretchko, "RF circuit design theory and applications", Pearson Education edition, 2004
	Reference Books:
1.	D. Pozar, Microwave Engineering, J. Wiley and Sons, 3rd Edition, 2004
2.	K. Chang, I. Bahl, and V. Nair, RF and Microwave Circuit and Component Design for Wireless Systems, J. Wiley & Sons, 2002
3.	1. G. Gonzalez, Microwave Transistor Amplifiers, 2nd Edition, Prentice Hall, 1997.
	E-resourses (NPTEL/SWAYAM)
1.	Prof. Bratin Ghosh, IIT Kharagpur, RF and Microwave Networks: https://nptel.ac.in/courses/108105189
2.	Prof. Amitabha Bhattacharya, IIT Kharagpur, Design Principles of RF and Microwave Filters and Amplifiers: https://nptel.ac.in/courses/117105138

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Understand the requirement of RF circuit for various applications.	Un	1,2,10,12	1,2
2.	Analyze various components for the given criteria.	An	1,2,3,4,5,9, 10,11,12	1,2
3.	Develop circuits for the required RF applications.	Ev	1,2,3,4,5,9, 10,11,12	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks

Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓								✓		✓	✓	✓	
2	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
3	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
Use tick mark(✓)															

Biomedical System Design

Course Code	22EC74C	Course type	PEC	Credits L-T-P	3–0-0
Hours/week: L - T- P	3–0–0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand basic concepts of semiconductor physics relevant to building circuit and device models.
2.	Understand the process of modelling a Human Physiological System.
3.	Describe and use physics-based devices and circuit models for biomedical applications.

Pre-requisites: Engineering Mathematics, Applied Electronic Circuits(21EC32), Embedded system design.

Unit – I	Contact Hours = 8 Hours

Introduction to System Science: Notion of dynamic systems: modeling and simulation using Simulation tool, Biomedical systems as dynamic systems, Compartmental modeling of biological systems, Eye movement model, Muscle model, Classical system identification. Moral and ethical issues in developing Biomedical Systems Morality and ethics, Two moral norms: beneficence and nonmaleficence, Human experimentation, Regulation of medical device innovation, Ethical issues in feasibility studies, Ethical issues in treatment use **Case Study:** Baroreceptor Modeling: An Interactive Cardiovascular Simulation.

Unit – II	Contact Hours = 8 Hours

Anatomy and Physiology: Introduction-Cellular organization – Tissues - Major organs and systems – Homeostasis, Bioelectric phenomena - Origin of bio-potentials - Notion of Hodgkin-Huxley and Soliton models - Biopotential measurements – ECG, EEG, EMG. **Case Study:** GE health care case study on

a) GE Mac 2000 ECG Machine, 12-lead Resting ECG System
b) GE Healthcare – Vscan Air CL Ultrasound System – H8031VA

Unit – III	Contact Hours = 8 Hours
Biomedical Sensors: Chemical biosensors – Electrochemical sensors and chemical fibro-sensors - Notion of ion selective field effect transistor (ISFET) and immunologically sensitive field effect transistor (IMFET) - Fundamentals of light propagation in biological tissue – Biophysical measurement techniques using light – photoplethysmography, Acoustic biosensors – phonocardiography – Photoacoustic bio-signals – estimation of blood glucose. **Case Study:** Biosensors for Personal Mobile Health: A System Architecture Perspective. (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7546526/)	

Unit – IV	Contact Hours = 8 Hours
Bio-signal processing: Characterization of bio-signals – morphological, statistical and transform features - Frequency domain representation of bio-signals – Noise characteristics - Noise reduction by Ensemble Averaging and Linear Time Invariant A Posteriori - filtering techniques - Signal averaging – Wavelet transform - Compression of bio-signals - lossless and lossy compression. Case Study: Neuro-Fuzzy Model for Arrhythmia Diagnostic System. https://pdfs.semanticscholar.org/591f/26b4940a59afa5762ea23a760f02ad152dbf.pdf	

Unit – V	Contact Hours = 8 Hours
Biomedical embedded systems and computational intelligence techniques: Choice of embedded core, Notion of Internet of Things as extended to biomedicine, Embedded processing for disease diagnosis, Wearable biomedical embedded systems, Point of care testing devices, Diagnostic processing for detection and classification of diseases. Computational intelligence techniques for disease diagnosis, Classification of cardiac, neuromuscular and neurological diseases. **Case Study:** Memory management issues for diagnostic processing - Power reduction techniques in diagnostic systems.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Unit No.	Self-Study Topics
1	**Case Study:** Baroreceptor Modeling: An Interactive Cardiovascular Simulation
2	**Case Study:** GE health care case study on a) GE Mac 2000 ECG Machine, 12-lead Resting ECG System
3	**Case Study:** Biosensors for Personal Mobile Health: A System Architecture Perspective
4	**Case Study:** Neuro-Fuzzy Model for Arrhythmia Diagnostic System

5	**Case Study:** Memory management issues for diagnostic processing - Power reduction techniques in diagnostic systems.

Books	
	Text Books:
1.	J. Enderle, S. Blanchard, J. Bronzino, "Introduction to Biomedical Engineering", Elsevier Academic Press, 2009.
2.	R. Begg, D.T.H. Lai, M. Palaniswami, "Computational Intelligence in Biomedical Engineering", CRC Press, 2008.
	Reference Books:
1.	L. Sornmo, P. Laguna, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", Elsevier Academic Press, 2005.
2.	J.G. Webster, "Medical Instrumentation: Application and Design", John Wileyand Sons,2003.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108108180
2.	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create	**Learning Level**	**PO(s)**	**PSO(s)**

1.	Understand the biomedical system design and apply for designing system model.	Un	1,2,4,8,12	1
2.	Understand and apply engineering concepts to describe many types of systems in biology and medicine. Systems include physiological systems (organs and systems level), bioelectronics systems, sensing and transducing systems, computational systems, etc	Ap	1,2,4,5,8,12	1
3.	Analyze physiological systems and design engineering systems to measure various pathophysiological parameters	An	1,2,4,5,8,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10+10=20	20 marks (with report & presentation)	100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	☑	☑		☑				☑				☑	☑		
2	☑	☑		☑	☑			☑				☑	☑		
3	☑	☑		☑	☑			☑				☑	☑		
Tick mark the CO, PO and PSO mapping															

Name & Signature of Faculty members involved in designing the syllabus

Name & Signature of Faculty members verifying/approving the syllabus

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Academic competence	GE Healthcare	Sales Executive/Engineer
2	ability to work as a part of a multidisciplinary team	Siemens	Research and development
3		Cardiac Labs	Service Engineer

Satellite Communication Technique

Course Code	**22EC74D**	**Course type**	**PE**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	8 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the fundamental concepts and principles of satellite communication systems, and analyze satellite communication links.
2.	Gain knowledge of different satellite communication techniques, to effectively design and optimize satellite communication systems.
3.	Develop skills in the analysis and design of satellite communication link budgets to ensure reliable and efficient satellite communication links.
4.	Acquire knowledge of satellite communication system components and understand their roles and characteristics, challenges and limitations in practical application.

Pre-requisites: Basic Electronics, Elements of Electrical Engineering, Principles of Communication Systems, Electromagnetic Theory and Antenna Engineering, Microwave and Radar.

Unit – I Introduction to Satellite Communication Systems	**Contact Hours = 8 Hours**
Overview of satellite communication systems, Historical development and milestones, Satellite orbits and constellations, Satellite link budget analysis, Satellite subsystems and components.	

Unit – II Satellite Communication Link Analysis	**Contact Hours = 8 Hours**
Satellite link design and parameters, Modulation techniques for satellite communication, Error control coding and decoding, Multiple access techniques in satellite communication, Satellite antenna systems and beamforming.	

Unit – III Satellite System Architecture and Protocols	**Contact Hours = 8 Hours**
Satellite system architecture and network topology, Satellite access protocols (TDMA, FDMA, CDMA), Routing and congestion control in satellite networks, Satellite network synchronization and timing, Quality of Service (QoS) considerations in satellite communication.	

Unit – IV Satellite Link Design and Performance Evaluation	**Contact Hours = 8 Hours**
Link budget calculation and analysis, Rain fade and atmospheric effects on satellite links, Link availability and outage prediction, Interference analysis and mitigation techniques, Satellite system performance evaluation and optimization.	

Unit – V Emerging Trends and Applications in Satellite Communication	**Contact Hours = 8 Hours**

Advanced satellite communication systems (LEO, MEO, HEO), Satellite constellations for global coverage, Satellite-based navigation and positioning systems (GPS, GNSS), Satellite broadcasting and multimedia services, Future directions and emerging technologies in satellite communication.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	"Satellite Communications" by Dennis Roddy, McGraw-Hill Education, 2015.
2.	"Satellite Communications Systems: Systems, Techniques and Technology" by Gerard Maral and Michel Bousquet, Wiley, 2013.
3.	"Introduction to Satellite Communication" by Bruce R. Elbert, Artech House, 2017.
4.	"Satellite Communication Engineering" by Michael Olorunfunmi Kolawole, Springer, 2017.
	Reference Books:
1.	"Satellite Communications and Navigation Systems" by Enrico Re, Artech House, 2008.
2.	"Satellite Communications: Payload and System" by Teresa M. Braun, Wiley, 2012.
3	"Satellite Communications: System and Its Design Technology" by Yoshio Inasawa, Peter Elby and Makoto Noda, John Wiley & Sons, 2011.
4	"Satellite Communication Systems Design" by SM Moghaddam, TMH, 2019.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Satellite Communication Systems, Prof. Kalyan Kumar Bandyopadhyay, Department of Electronics and Electrical Communication Engineering, Indian Institute of Technology, Kharagpur https://archive.nptel.ac.in/courses/117/105/117105131/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create		Learning Level	PO(s)	PSO(s)
1.	Recall and recognize the key concepts and principles of satellite communication systems in all aspects.	Un	1, 2, 3, 6, 10	1

2.	Comprehend the different satellite communication techniques, multiple access schemes, modulation and coding techniques, and error control mechanisms.	Ap	1, 2, 3, 6, 9, 10	1
3.	Apply the knowledge and skills in the analysis and design of satellite communication link budgets system performance parameters.	Ap	1, 2, 3, 6, 9, 10	1, 2
4.	Analyze the various components of satellite communication systems, their roles and characteristics in the system architecture and operation, and the challenges and limitations in practical application.	An	1, 2, 3, 6, 9, 10	1, 2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓	✓			✓				✓			✓		
2	✓	✓	✓			✓			✓	✓			✓		
3	✓	✓	✓			✓			✓	✓			✓	✓	
4	✓	✓	✓			✓			✓	✓			✓	✓	

Vehicular Networks

Course Code	22EC74E	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the emerging technologies, standards, vanet architectures and applications in Intelligent transportation systems.
2.	To study the design considerations and challenges of vehicle-to-infrastructure and vehicle-to-vehicle communications.
3.	To demonstrate vehicular mobility modeling using vehicular technologies and standards from the physical to network layers.

Pre-requisites: Digital communication, analog communication, Computer Networks.

Unit – I	**Contact Hours = 8 Hours**
Introduction to VANETs, architectures, vehicle to vehicle, vehicle to infrastructure and vehicle to cloud, VANET requirements, applications, communication technologies, wireless access for vehicular environments (WAVE) and direct short-range communication (DSRC). VANET performance parameters.	

Unit – II	**Contact Hours = 8 Hours**
Enabling Technologies and challenges: Introduction, Motivation, Enabling Technologies, Communication requirements, Vehicular positioning, Vehicle sensors, On-board computation platforms, Cooperative System Architecture, Mapping for Safety Applications, Non-parametric, Path Prediction, Parametric, Path prediction Stochastic, path prediction, VANET-enabled Active Safety Applications, Infrastructure-to-vehicle applications, Vehicle-to-vehicle applications, Pedestrian-to-vehicle applications.	

Unit – III	**Contact Hours = 8 Hours**
Protocols: Introduction, Obtaining Local Measurements, Information Transport, Protocols for information transport, improving network connectivity, Summarizing Measurements, Geographical Data Aggregation.	

Unit – IV	**Contact Hours = 8 Hours**

Computational Models: Introduction, Limitations, Capacity, Connectivity, Competition, Applications, Communication Paradigms, Centralized client/server systems, Infrastructure-based peer-to-peer communication, VANET communication, Vehicular Mobility Modeling for VANET, Notation Description, Random Models.

Unit – V	**Contact Hours = 8 Hours**
Flow Models and DSRC: Microscopic flow models, Macroscopic flow models, Mesoscopic flow models, Traffic Models, Layered Architecture for VANETs, General concepts and definitions, A protocol stack for DSRC.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	VANET: Vehicular Applications and Inter-Networking Technologies by Hannes Hartenstein and Kenneth P Laberteaux. Wiley publishers.
2.	Introduction to Vehicular Wireless Networks by raj Jain.
	Reference Books:
1.	Holger Kerl, Andreas willig, protocols and Architectures for wireless Sensor Network<, John wiley and Sons
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	http://www.cse.wustl.edu/~jain/cse574-18/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Assignment- Open/Industry/Certification
3.	Flipped Classes	3.	Course Project
4.	Online classes	4.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the action verb representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain architecture of vehicular adhoc networks	Re	1,2,10	1
2.	Distinguish various vanet architectures	Un	1,2,10	1
3.	Derive expressions for performance parameters	Ap	1,2,10	1

4.	Analyze and Design vanet applications	An	1,2,10	1
5.	Analyze various Data Storage and manipulation techniques.	An	1,2,10	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓													
2	✓									✓					
3	✓														
4	✓	✓													
5	✓	✓								✓					
Tick mark the CO, PO and PSO mapping															

NATURAL LANGUAGE PROCESSING

Course Code	22EC74F	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand foundational concepts and techniques of Natural Language Processing (NLP) including text preprocessing, word embeddings, and deep learning models, and apply them to real-world problems.
2.	To gain proficiency in implementing and utilizing advanced NLP models such as recurrent neural networks (RNNs), transformer networks, and attention mechanisms.
3.	To develop skills in performing syntactic analysis and parsing tasks including dependency parsing and constituency parsing.
4.	To explore emerging trends and applications in NLP such as machine translation, question-answering systems, and language generation.

Pre-requisites : Fundamentals Deep Learning and artificial neural network

Unit – I	**Contact Hours = 8 Hours**
Introduction to NLP and Deep Learning Introduction to Natural Language Processing, Applications of Natural Language Processing, Introduction to Word2Vec, Word2Vec objective function and gradients. **Case study on Analyzing customer reviews using NLP techniques to determine their sentiment.**	

Unit – II	**Contact Hours = 8 Hours**
Dependency Parsing and Recurrent Neural Networks Dependency Grammar, Neural dependency parsing, Introduction to Recurrent Neural Networks, (RNNs), Language models with RNNs, Vanishing Gradients problem, Fancy RNNs (e.g., LSTM, GRU). **Case study on Identifying and classifying named entities in text data for efficient information retrieval.**	

Unit – III	**Contact Hours = 8 Hours**
Machine Translation and Attention Mechanism Machine Translation, Sequence-to-Sequence (Seq2Seq) models, Introduction to Attention mechanism, Advanced concepts in Attention mechanism. **Case study on Developing a system for automatic translation of text between different languages.**	

Unit – IV	Contact Hours = 8 Hours
Transformer Networks and Advanced NLP Tasks Transformer Networks for NLP, Coreference Resolution, Memory Networks for NLP, Tree Recursive Neural Networks and Constituency Parsing, Advanced architectures in NLP. **Case study on Building an intelligent system that can accurately answer user questions based on textual information by learning NLP libraries and tools like NLTK, spaCy, and TensorFlow.**	

Unit – V	Contact Hours = 8 Hours
Reinforcement Learning and Future of NLP Reinforcement Learning for NLP, Semi-supervised Learning for NLP, Future directions of NLP models, Multi-task Learning in NLP, Question-Answering (QA) Systems. **Case study on Categorizing documents or text data into specific classes or categories using NLP algorithms.**	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Goldberg, Y, A Primer on Neural Network Models for Natural Language Processing. Morgan & Claypool Publishers, 2016
2.	Bird, S., Klein, E., & Loper, E, Natural Language Processing with Python. O'Reilly Media. 2009
3.	L. Ashok Kumar, D. Karthika Renuka, Deep Learning Approach for Natural Language Processing, Speech, and Computer Vision, CRC Press, 2023
	Reference Books:
1.	Palash Goyal, Sumit Pandey, Karan Jain, and Karan Nagpal, Deep Learning for Natural Language Processing: Creating Neural Networks with Python, 2020
2.	Paul Azunre, Transfer Learning for Natural Language Processing, Manning Publications, 2021.
3.	Jacob Eisenstein, Natural Language Processing, MIT Press, 2019
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	"Natural Language Processing", By Prof. Pawan Goyal, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc23_cs80/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)

4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓							✓	✓	✓	
2	✓	✓	✓		✓		✓	✓				✓	✓	✓	✓
3	✓	✓	✓		✓		✓	✓				✓	✓	✓	✓
4	✓	✓			✓							✓	✓	✓	
Use tick mark(✓)															

Human Computer Interaction

Course Code	22EC74G	**Course type**	PE	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	2 Hours			**SEE Marks**	100

Course learning objectives	
1.	Learn the basics of human-computer interaction, interactivity, interaction styles, models of interaction and framework of human-computer interaction.
2.	Study how software engineering and the design process relate to interactive system design and understand the design rules to develop an effective design process and a universal design.
3.	Learn the programming support tools available for implementing interactive systems and improve the abstraction by use of toolkits. Study the evaluation techniques and design of user support systems.
4.	Study the implementation and applications of groupware, ubiquitous computing and augmented realities applied to interactive systems.

Pre-requisites : Nil

Unit – I	**Contact Hours = 8 Hours**

Foundation:

Introduction to human and computer, The Interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of WIMP interface, Interactivity.

Case Study: Paradigms for interaction

Unit – II	**Contact Hours = 8 Hours**

The Design Process:

Interaction design basics: the process of design, user focus, scenarios, navigation design, screen design and layout, iteration and prototyping. HCI in software process: software life cycle, usability engineering, iterative design and prototyping, design rationale. Design rules: principles, standards, guidelines, golden rules and heuristics, HCI patterns. Universal design: Universal design principles, Multi-modal interaction.

Case Study: Designing for diversity

Unit – III	**Contact Hours = 8 Hours**

Models of Interactive Systems:

Standard formalism, Cognitive models: Goal and task hierarchies, Linguistic models, challenge of display-based systems, Physical and device models, and Cognitive architectures. Interaction models, modeling rich interaction.

Case Study: Socio-organizational issues and stakeholder requirements

Unit – IV	**Contact Hours = 8 Hours**
Implementation and Evaluation: Implementation support: Elements of windowing systems, Programming the application, using toolkits, User interface management systems. Evaluation techniques: Goals of evaluation, Evaluation through expert analysis, choosing an evaluation method. User support: Requirements of user support, Approaches to user support, Adaptive help systems, Design of user support systems. **Case Study**: Evaluation through user participation	

Unit – V	**Contact Hours = 8 Hours**
Interactive System Applications: Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, implementing synchronous groupware. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. **Case Study**: Hypertext, Multimedia and the World Wide Web	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**0**	**0**	**1**	**1**	**0**

Books	
	Text Books:
1.	Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russell Beale, “Human-Computer Interaction”, 3rd Edition, Pearson Education Limited, 2004.
	Reference Books:
1.	Preece, J., Rogers, Y., & Sharp, H., “Interaction design: Beyond human-computer interaction”, 4th Edition, John Wiley & Sons Limited, 2015.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://www.hcibook.com/e3/online/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the basic elements of human-computer interaction.	Un	1,6,8,9,10,11,12	1,3
2.	Analyze different models of interactive systems and their implementation and evaluation.	An	1,2,6,8,9,10,11,12	2,3
3.	Apply groupware, ubiquitous computing and augmented reality technologies in an interactive system.	Ap	1,2,6,8,9,10,11,12	1,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓					✓		✓	✓	✓	✓	✓	✓		✓
2	✓	✓				✓		✓	✓	✓	✓	✓		✓	✓
3	✓	✓				✓		✓	✓	✓	✓	✓	✓		✓
Use tick mark(✓)															

Multirate Digital Signal Processing

Course Code	**22EC74I**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	05 Hours			**SEE Marks**	100

Course learning objectives	
1.	Introduce concepts of linear filtering (single rate filter design).
2.	Understand basic multirate operations.
3.	Introduce working and design of various filter banks
4.	Explore the concept of perfect reconstruction in filterbanks.

Pre-requisites: Signals and Systems, Digital Signal Processing

Unit – I	**Contact Hours = 8 Hours**
Introduction, **Review of Digital Filters (Linear Filtering)** **Filter Design Specifications, FIR Filter Design, IIR Filter Design, Allpass Filters, Special Types of Filters, IIR Filters Based on Two Allpass Filters**	

Unit – II	**Contact Hours = 8 Hours**
Fundamentals of Multirate Systems: **Basic Multirate Operations, Interconnection of Building Blocks, The Polyphase Representation, Multistage Implementations, Applications of Multirate Systems, Special Filters and Filter Banks**	

Unit – III	**Contact Hours = 8 Hours**
Maximally Decimated Filter Banks: **Introduction, Errors Created in the QMF Bank, A Simple Alias-Free QMF System, Power Symmetric QMF Banks, M-channel Filter Banks, Polyphase Representation, Perfect Reconstruction (PR) Systems, Alias-Free Filter Banks, Tree Structured Filter Banks, Transmultiplexers**	

Unit – IV	**Contact Hours = 8 Hours**
Paraunitary Perfect Reconstruction (PR) Filter Banks: **Introduction, Lossless Transfer Matrices, Filter Bank Properties Induced by Paraunitariness, Two Channel FIR Paraunitary QMF Banks, The Two Channel Paraunitary QMF Lattice, M-channel FIR Paraunitary Filter Banks, Transform Coding and the "LOT"**	

Unit – V	Contact Hours = 8 Hours
Linear Phase Perfect Reconstruction QMF Banks: **Introduction, Some Necessary Conditions, Lattice Structures for Linear Phase FIR PR QMF Banks, Formal Synthesis of Linear Phase FIR PR QMF Lattice** **Cosine Modulated Filter Banks:** **Introduction, The Pseudo QMF Bank, Design of the Pseudo QMF Bank, Efficient Polyphase Structures, Deeper Properties of Cosine Matrices, Cosine Modulated Perfect Reconstruction Systems**	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Publications, 2013 onwards.
	Reference Books:
1.	Roberto Cristi, Modern Digital Signal Processing, CENGAGE Publications, 2009 onwards.
2.	J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Publications, 2017 onwards.
3.	A. V. Oppenheim, R. W. Schafer and J. R. Buck, Discrete Time Signal Processing, Pearson Publications, 2021 onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Multirate DSP by Prof. R. David Koilpillai, IIT Madras, Link: https://onlinecourses.nptel.ac.in/noc20_ee21/preview
2.	Foundations of Wavelets and Multirate Digital Signal Processing by Prof. V. M. Gadre, IIT Bombay, link: https://nptel.ac.in/courses/117101123

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand the fundamental concepts and designs of digital filters, multirate systems, and perfect reconstruction techniques**	Un	1,2,3,5,10	1,2
2.	**apply digital signal processing techniques to design and implement various filters and multirate systems for practical applications**	Ap	1,2,3,5,10	1,2
3.	**analyze the performance, limitations, of multirate digital signal processing systems and filter banks**	An	1,2,3,5,10	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	✓	✓	✓		✓					✓			✓	✓	
2	✓	✓	✓		✓					✓			✓	✓	
3	✓	✓	✓		✓					✓			✓	✓	
Use tick mark(✓)															

DIGITAL FORENSICS

Course Code	22EC751	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the key aspects of Digital Forensics.
2.	To study the nature of a typical digital forensics case, the correct procedures for searching and seizing evidence and evaluation of a case.
3.	To study the E-mail and Social Media Investigations related to Digital Forensics.
4.	To comprehend the Mobile Device Forensics and Cloud Forensics.

Pre-requisites: Basics of electronic systems

Unit – I	**Contact Hours = 8 Hours**
Understanding the digital forensics profession and investigations: an overview of digital forensics, preparing for digital investigations, maintaining professional conduct, preparing a digital forensics investigation, procedures for private-sector high-tech investigations, understanding data recovery workstations and software, conducting an investigation **Data acquisition:** understanding storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, using acquisition tools **Case Study:** Study of Redundant Array of Independent Disks (RAID) Data Acquisition from a computer.	

Unit – II	**Contact Hours = 8 Hours**
Processing crime and incident scenes: identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case. **Case Study:** Study of SHA-1, MD5	

Unit – III	**Contact Hours = 8 Hours**
Working with windows and Command Line Interface systems: understanding file systems, exploring Microsoft file structures, examining NTFS disks, understanding whole disk encryption, understanding the windows registry, understanding virtual machines **Digital forensics analysis:** determining what data to collect and analyze, addressing data-hiding techniques **Case study:** Understanding bootstrap loader sequence in a computer.	

Case Study:
1.Identify the applications of RSA in public key cryptosystems.
2. Develop a code for implementing simple hash function.

Unit – IV	**Contact Hours = 8 Hours**
E-mail and social media investigations: exploring the role of e-mail in investigations, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensics tools, applying digital forensics to social media. **Case Study:** 1. Study of "Elephant in the Room: Case Studies of Social Media in Civil and Criminal Cases," Mark Lanterman, http://blog.x1discovery.com/2014/06/10/elephantin-the-room-case-studies-of-social-media-in-civil-and-criminal-cases/, June 2014. 2. Demonstrate the use of Forensic Toolkit (for Face book by Afentis Software) to discover friends and other information of a public profile.	

Unit –V	**Contact Hours = 8 Hours**
Mobile device forensics: understanding mobile device forensics, understanding acquisition procedures for mobile devices **Cloud forensics:** an overview of cloud computing, legal challenges in cloud forensics, technical challenges in cloud forensics, acquisitions in the cloud, conducting a cloud investigation, tools for cloud forensics **Case Study:** Study of SIM Manager tool to read the sim card messages.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations: Processing Digital Evidence", Fifth Edition, Cengage Learning, 2015 and onwards.
2.	Cory Altheide, Harlan Carvey, "Digital Forensics with Open Source Tools", Elsevier, Syngress publications, 2011 and onwards.
	Reference Books:
1.	John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Second Edition, ISBN 1-58450-389-0, 2005 and onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links

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

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the basic concepts of digital forensics and study the forensic tools.	Ap	1,3,4,5,6,8	1
2.	Analyze the forensic data acquired from an electronic system.	An	1,3,4,5,6,8	1
3.	Analyze the e-mail and social media digital forensics and document.	Ev	1,3,4,5,6,8	1
4.	Understand the digital forensics applied to mobile and cloud scenario.	Ap	1,3,4,5,6,8	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
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-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
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CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	✓		✓	✓	✓	✓		✓					✓		
2	✓		✓	✓	✓	✓		✓					✓		
3	✓		✓	✓	✓	✓		✓					✓		
4	✓		✓	✓	✓	✓		✓					✓		
Use tick mark(✓)															

BIO MEDICAL IMAGE UNDERSTANDING AND ANALYSIS

Course Code	**22EC752**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3 - 0 - 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Identify applications of different Radiological modalities for solving real time problems
2.	Appreciate the use and applications of transforms in extraction of features from objects
3.	Appreciate the evolution of Deep Neural Network from ANN
4.	Design and deploy simple Convolution Neural Network (CNN) model for Biomedical Image classification and identification for specific Radiological Modalities.

Required Knowledge of: Linear Algebra, Statistics and Probability

Unit – I	**Contact Hours = 8 Hours**

Introduction to Biomedical Image Processing

Digital Image Processing, Biomedical Image Processing, System, Medical Image modalities, Image Algebra, Image transform (FT, DCT, DWT, HOUGH, KL) Image Enhancement in spatial and frequency domain, Image Restoration, Medical applications of Imaging, Frontiers of Image processing in Medicine.

Privacy and Ethics in Handling Clinical Data for Experiments: Ensuring privacy and ethics in handling clinical data for experiments is essential to protect patient confidentiality and uphold ethical standards.

Practical Session : Introduction to Mathwork Matlab and Image Processing Toolbox / Python coding

Case study review on Image Morphology, Image Fusion, Image Super Resolution

Unit – II	**Contact Hours = 8 Hours**

Artificial Neural Networks and Evolutions of Deep Learning

Over view of Biological Neural Networks (BNN), McCulloch-Pitts Neuron Model of Biological Neuron, Artificial Neuron Basic Element and its structure, Different activation function, Training, Testing and Validation, Forward and Back propagation with example, Single layer Feed forward network, Multi-layer Feed forward network, classification of learning algorithms, Limitations of Artificial Neural Networks (ANN), Evolutions of Deep Learning.

Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding

Case study review on Artificial Neural Networks and Biomedical Image applications

Unit – III	**Contact Hours = 8 Hours**

Convolution Neural Networks and Applications Introduction to Convolutional Neural Networks (CNNs / ConvNets), architecture overview and terminologies of CNN, motivation behind CNN, study of architecture and comparisons of pretrained CNN (limited to only **LeNet-5,ResNet -34 and ResNet -50**). **Case study review on to Convolutional Neural Networks (CNNs / ConvNets)and Biomedical Image applications** **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding**

Unit – IV	**Contact Hours = 8 Hours**
Deep Learning Medical Image Segmentation Introduction to Digital Image Segmentation, operators - filters for edge and line detection, simple segmentation algorithms, significance of Image Segmentation in Medical Image, classification of digital image segmentation algorithms, automatic image segmentation, Architecture of U-Net and V-net segmentation. **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding** **Case study review on Biomedical Image Segmentation**	

Unit –V	**Contact Hours = 8 Hours**
Deep Learning Medical Image Classification, Analysis and Visualization Features, Features reduction using Principal Component Analysis (PCA), feature reduction using Image Transforms (DWT), Pre trained CNN Model for feature extraction (only **ResNet -50**),Example and demonstration of CNN pretrained model for image classification and Identification. **Practical Session: Introduction to Mathwork Matlab Deep Learning Toolbox/ Python coding** **Case study review on Pre trained CNN Model**	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Unit No.	**Self-Study Component**
1.	Linear algebra and probability
2.	Learning algorithms and intelligence in algorithm
3.	LeNet -5 CNN Architecture for number classification
4.	Semantic Segmentation and nnU-net
5.	Clustering algorithm for image classification in Biomedical Imagery applications

Books	
	Text Books:
1.	Geoff Dougherty, "Digital Image Processing for Medical Applications", Cambridge University Press, 2nd Edition, 2013.

2.	Kevin Zhou, Medical Image Recognition, Segmentation and Parsing: Machine Learning and Multiple Object Approaches, 1st Edition, Elsevier Science, 2015
	Reference Books:
1.	Kevin Zhou, Hayit Greenspan and Dinggang Shen, Deep Learning for Medical Image Analysis Elsevier Science, 2017
2.	Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Debdoot Sheet, Indian Institute of Technology Kharagpur, MEDICAL IMAGE ANALYSIS, NPTEL course Link: https://nptel.ac.in/courses/108/105/108105091/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	**Mini Project**		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply knowledge of deep learning algorithms to solve real life problems related to health care and radiology.	Ap	1,2,12	1,2
2.	Analyze the state of art techniques applied in deep learning research	An	1,2,12	1,2
3.	Evaluate the effectiveness of deep learning models in healthcare classification and identification using suitable datasets.	Ev	1,2,3,5,6,8,12	1,2,3
4.	Analyze different deep learning models for different applications of Diseases detection and identification using Computed tomography (CT) and Magnetic Resonance Imaging (MRI).	An	1,2,3,5,6,8,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓			✓							✓	✓	✓	
2	✓	✓			✓							✓	✓	✓	
3	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
4	✓	✓		✓	✓	✓		✓				✓	✓	✓	✓

Artificial Neural Networks

Course Code	22EC753	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand different neural network models.
2.	Explore the hard problems and apply multilayer neural networks solve the same.
3.	Understand and interpret the energy analysis applied to Regression neural networks.
4.	Explore different architectures of neural networks for different set tasks.

Pre-requisites : Basic Mathematics

Unit – I	Contact Hours = 8 Hours
Fundamentals of ANN, Biological Neurons and Their Artificial Models, Types of ANN, Properties, Different Learning Rules, Types of Activation Functions, Training of ANN, Perceptron Model (Both Single &Multi-Layer), Training Algorithm, Problems Solving Using Learning Rules and Algorithms, Linear Separability Limitation and Its Over Comings. **Case Study:** Identify an application and analyze its performance using any two network models.	

Unit – II	Contact Hours = 8 Hours
Back Propagation Networks (BPN), Training, Architecture-Algorithm, Counter Propagation Network (CPN), Training, Architecture, Bi-Directional Associative Memory (BAM), Training-stability analysis, Adaptive Resonance Theory, Adaptive Resonance Theory (ART) ART1- ART2, Architecture, Training, Hop Field Network, Energy Function, Discrete Continuous, Algorithm, Application, Travelling Sales Man Problem TSP. **Case Study:** Linear separability, Perceptron convergence theorem.	

Unit – III	Contact Hours = 8 Hours
Self organizing networks-Introduction, Kohonan SOM, Linear vector quantization, Probabilistic neural network, Cascade correlation, General Regression neural network, Cognitron, Application of ANN, Texture classification, Character recognition. **Case Study:** Review a research paper on CNN application and analyze the architecture.	

Unit – IV	Contact Hours = 8 Hours
Classical set, Operations and properties, Fuzzy Set, Operations and properties, Problems, Classical Relations ,Operations and Properties, Fuzzy Relations, Operations and Properties, Compositions Membership function, FLCS, Need for FLC-Fuzzification, Defuzzification. **Case Study:** Compare the different parameters of feedback neural networks with each other	

Unit –V	Contact Hours = 8 Hours
Fuzzy decision making,Types, Fuzzy Rule Based System, Knowledge Based System, Nonlinear Fuzzy Control system, Fuzzy Classification, Hard C Means, Fuzzy C Means. Applications of fuzzy, Water level controller, Fuzzy image Classification, Speed control of motor. **Case Study:** Compare RBF with MLP networks.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	B. Yegnanarayana, Artificial neural networks", PHI, 2010 onwards.
2.	Robert J. Schalkoff, "Neural Networks for Pattern Recognition", Mcgraw-Hill Inc onwords.
	Reference Books:
1.	Simon Haykin, "Neural Networks and Learning Machines", Pearson Education, 3rd edition, 2008 onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://onlinecourses.nptel.ac.in/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	Learning Level	PO(s)	PSO(s)
1.	Analyze performance of different neuron models with reference to identified application.	Ap	1,2,4,5	1
2.	Apply multilayer neural networks to solve hard problems.	Ap	1,2,4,5	1
3.	Compare different neural network architectures applied to complex pattern recognition tasks.	An	1,2,4,5	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks

Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
1	✓	✓	✓	✓	✓							✓	✓		
2	✓	✓	✓	✓	✓							✓	✓		
3	✓	✓	✓	✓	✓							✓	✓		
4	✓	✓	✓	✓	✓							✓	✓		
5	✓	✓	✓	✓	✓							✓	✓		
Use tick mark(✓)															

Computational Intelligence and Application

Course Code	22EC754	**Course type**	OE	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Develop a comprehensive understanding of computational intelligence, fuzzy logic, and neural networks.
2.	Explore and analyse various neural network architectures and their applications.
3.	Acquire in-depth knowledge of the fundamental principles, concepts, and operations of fuzzy logic.
4.	Design and implement effective fuzzy logic systems, including creating rule bases, defining membership functions, and implementing fuzzy inference mechanisms.

Pre-requisites : Mathematical fundaments and set theory, fundamentals of Linear Algebra

Unit – I	**Contact Hours = 8 Hours**
Introduction to Computational Intelligence Overview of computational intelligence and its applications, Introduction to neural networks, fuzzy logic, evolutionary computation, swarm intelligence, and machine learning. **Case study on Energy Management in Smart Grids using computational intelligence.**	

Unit – II	**Contact Hours = 8 Hours**
Fundamentals of Artificial Neural Network Perceptron, artificial neuron, artificial neuron implementation, different activation functions for binary and multilabelled classification. Logic development using simple perceptron, single layer perceptron, multilayer perceptron, artificial neural learning, forward propagation and back propagation algorithm and application. **Applications of Artificial Neural Networks (ANNs)** Image and Speech Recognition, Natural Language Processing, Time Series Prediction, Pattern Recognition and Classification. **Case study on Fraud Detection in Financial Transactions using computational intelligence.**	

Unit – III	**Contact Hours = 8 Hours**
Fuzzy Set theory and Fuzzy System **Fuzzy set theory:** Introduction to Fuzzy Set, Membership, Operations, Properties, Fuzzy Relation. **Fuzzy system:** Introduction, FL, Fuzzification, Fuzzy Inference, F Rule Based System, Defuzzification. **Applications of fuzzy system:**	

Fuzzy rule-based traffic signal optimization, Fuzzy logic-based medical diagnosis systems, Fuzzy logic-based power system stability analysis, Fuzzy rule-based decision support systems for financial risk assessment.

Case study on Medical Diagnosis and Treatment using computational intelligence.

Unit – IV	**Contact Hours = 8 Hours**

Associative Memory

Fuzzy Associative Memory, - Fuzzy associative memories (FAMs) pattern recognition and retrieval in fuzzy logic systems and Associative Neural Memory.

Applications of Associative Memory: Efficient data storage and retrieval in large-scale databases, Image and video processing for object recognition and tracking, Speech recognition and natural language processing, financial forecasting and time series analysis, Fault diagnosis and anomaly detection in complex systems.

Case study on Autonomous Vehicle Navigation using computational intelligence.

Unit – V	**Contact Hours = 8 Hours**

Applications of Neuro-Fuzzy

Neuro-Fuzzy System Fundamentals, Neuro-Fuzzy Modeling, Neuro-Fuzzy Pattern Recognition application, Neuro-Fuzzy Time Series Prediction and analysis, Neuro-Fuzzy Fault Diagnosis and Neuro-Fuzzy Applications in Healthcare.

Case study on Predictive Maintenance in Manufacturing using computational intelligence.

Unit No.	**Self-Study Topics**
1	Exponential models, Time series models.
2	Multiple linear regression, Multivariate linear regression, Generalized linear models.
3	Machine learning and compressed sensing.
5	Sparse signal representation, kernel and sparse kernel

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions **Mini -Project and Case Study in each Unit**	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Andries P. Engelbrecht, "Computational Intelligence: An Introduction, Second Edition", Wiley, 2007.
2.	Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Pearson, 2008.
	Reference Books:

1.	Nikola K. Kasabov, "Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering", MIT Press, 1996.
2.	Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall, 1992.
3.	Bart Kosko, "Fuzzy Engineering", Prentice Hall, 1997.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Approximate Reasoning Using Fuzzy Set Theory, By Prof. Balasubramaniam Jayaram, IIT Hyderabad https://onlinecourses.nptel.ac.in/noc23_ma60/preview
2.	Introduction To Fuzzy Set Theory, Arithmetic And Logic, By Prof. Niladri Chatterjee, IIT Delhi https://onlinecourses.nptel.ac.in/noc23_ma73/preview
3.	Deep Learning for Computer Vision, By Prof. Vineeth N Balasubramanian, IIT Hyderabad https://onlinecourses.nptel.ac.in/noc21_cs93/preview

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
5.		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the foundational principles and concepts of computational intelligence, including neural networks and fuzzy logic.	**Re**	1,2, 12	1,2
2.	Apply computational intelligence techniques effectively to solve complex problems.	**Ap**	1,2, 12	1,2
3.	Analyze and evaluate computational intelligence algorithms and models critically.	**An**	1,2,12	1,2,3
4.	Design and implement innovative computational intelligence solutions for real time application.	**An**	1,2,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓										✓	✓		
2	✓	✓										✓	✓		
3	✓	✓					✓					✓	✓	✓	✓
4	✓	✓										✓	✓	✓	✓
Tick mark the CO, PO and PSO mapping															

Fundamentals of Robotics

Course Code	**22EC755**	**Course type**	OEC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	3 Hours			**SEE Marks**	100

Course learning objectives	
1.	Explain the fundamentals of industrial automation and robotics
2.	Explain the different types of actuators, motors, grippers used in robot drive system
3.	Explain the applications of robots in various fields
4.	Apply the knowledge of Sensors and actuators in building robotic systems

Pre-requisites: Fundamentals of Electronics, Fundamentals of Physics

Unit – I	**Contact Hours = 8 Hours**
Fundamentals of Robot: Introduction, industrial robot, robot, laws of robotics, types of robots, robot specification, benefits of robot, need for robot, manufacturing applications of robot, the future of robotics **Case Study:** Conduct a survey on Non-manufacturing robotic applications.	

Unit – II	**Contact Hours = 8 Hours**
Robot Drive Systems and End Effectors: Introduction, actuators, types of actuators or drives, DC servomotor, types of D.C. motors, A.C. motors, stepper motor, selection of motors, Comparison of pneumatic, hydraulic electrical drives, end-effectors, grippers. **Case Study:** Study the control of a two-wheeled robot	

Unit – III	**Contact Hours = 8 Hours**
Sensors: Sensors, requirements and classification of sensors, position sensors, force sensors, external sensors: Electro-mechanical sensors. **Case Study:** Identify an application that uses machine vision for obstruction detection.	

Unit – IV	**Contact Hours = 8 Hours**
Control Methods: Performance objectives, electrical power, servo-controlled robots, non-servo controlled robots, actuators, controllers, programmable controllers. **Robot Programming**: Introduction, methods for robot programming, defining a robot program, method of defining position in space, motion interpolation, basic programming commands in work-cell control. **Case Study:** Understand the working principles of a robotic arm control system.	

Unit –V	**Contact Hours = 8 Hours**

Uses for Robots: Performance objectives, loading and unloading, materials handling, fabricating, assembling, painting, welding, inspecting and testing, the future of flexible automation, objectives of CIM, the future of robots, social impact of robots, new uses and new forms. **Case Study:** Design a simple automation system that employs the knowledge of sensors and actuators.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Ramachandran S., "Robotics", AIRWALK PUBLICATIONS (2017), ISBN: 978-9384893-69-9
2.	Rex Miller, Mark R. Miller - Robots and Robotics_ Principles, Systems, and Industrial Applications-McGraw-Hill Education (2017)
3.	Mike Wilson - Implementation of Robot Systems_ An introduction to robotics, automation, and successful systems integration in manufacturing-Butterworth Heinemann (2014)
	Reference Books:
1.	Lina J. Karam, Naji Mounsef - Introduction to Engineering_ A Starter's Guide with Hands-on Digital and Robotics Explorations (Synthesis Lectures on Engineering)
2.	John J. Craig - Introduction to Robotics Mechanics and Control 3rd edition-Pearson Education, Inc. (2005)
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/108/105/108105063/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create		Learning Level	PO(s)	PSO(s)
1.	Understand the fundamentals of Robotics.	Un	1,12	1
2.	Compare and identify the appropriate actuators and sensors required for the robotic application.	Ap	2,3,9,10,11,12	1
3.	Analyze the performance of various applications and compare different programming aspects in these applications.	An	5,9,10,11,12	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two Assignments – (Open /Industry/Certification etc)	Course project (CP)/ Case study etc	Total Marks
Marks	30+30 = 60	10 + 10 = 20	20 marks (with report & presentation)	100

-Certification earned by passing the standard Online MOOCs course (1 course of atleast 8 hours defined by BOS) can be considered as a Course activity and awarded maximum of 10 marks.
-Student should score minimum 40% of 60 marks (i.e. 24 marks) in IA tests.
-Lack of minimum score in IA test will make the student Not Eligible for SEE
-Minimum score in CIE to be eligible for SEE: 40 OUT OF 100.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 out of 7 questions, each Question Carries 6 Marks. 2. From Part B answer 5 out of 10 questions choosing any one full question from each unit, each Question Carries 10 Marks. 3. From Part C answer 1 out of 2 questions, each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO3**
1	✓											✓	**1**		
2		✓	✓						✓	✓	✓	✓	**1**		
3					✓				✓	✓	✓	✓		**1**	
Use tick mark(✓)															