Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Udumalai Road, Pollachi, Coimbatore District - 642003
Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University
(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)
An Autonomous Institution
Since 2011
NAAC A++ GRADE
Cycle 3 (2023-2030)
The Highest Grade

Curriculum and Syllabi

Semesters I to VIII

Regulations 2023

(2023 Batch only)

Dr. Mahalingam College of Engineering and Technology, Pollachi 642003.

(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Electronics and Communication Engineering

Electronics and Communication (Advanced Communication Technology)

Vision

To strive for excellence in Electronics and Communication Engineering education, research and technological services imparting quality training to students, to make them competent and motivated engineers.

Mission

- Impart high quality technical education in Electronics and Communication Engineering through effective teaching- learning process and updated curriculum.
- Equip the students with professionalism and technical expertise to provide appropriate solutions to societal and industrial needs.
- Provide stimulating environment for continuously updated facilities to pursue research through creative thinking and team work.

Programme Educational Objectives (PEOs) – Regulations 2023

B.E. Electronics and Communication (Advanced Communication Technology) graduates will:

PEO1. Actively apply knowledge and technical skills in engineering practices towards the progress of the organization in competitive and dynamic environment.

PEO2. Own their professional and personal development by continuous learning and apply the learning at work to create new knowledge.

PEO3. Conduct themselves in a responsible and ethical manner supporting sustainable economic development which enhances the quality of life.

Programme Outcomes (POs) - Regulations 2023

On successful completion of B.E. Electronics and Communication (Advanced Communication Technology) programme, graduating students/graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review 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 the specified needs with appropriate consideration for the public health and safety, and the 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 the 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 modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the 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 the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs) - Regulations 2023

On successful completion of B.E. Electronics and Communication (Advanced Communication Technology) programme, graduating students/graduates will be able to:

PSO1: Advanced Communication System Design: Design and implement advanced communication systems while leveraging simulation tools and hardware platforms.

PSO2: Emerging Wireless Technologies: Develop expertise in wireless protocols such as MIMO, mmWave, and SDR systems to create innovative solutions for high-speed data transmission, energy-efficient communication, and reliable network connectivity.

Dr.Mahalingam College of Engineering and Technology,Pollachi

2023 Regulations - Course Code Generation Procedure for UG Courses

Regulation

Mode of Assessment	
Character Type – Number	
T	Theory
I	Theory with Practical
L	Practical
	Practical with Theory
E	Elective
O	Open Elective
P	Project
S	Skill Development Course/Internship
C	Customized

Semester Number	
Character Type – Number	
1 to 8	Semester
0	Floating

Sequence Number
Character Type – Number
01, 02, 03, . . . , 99

1	2	3	4	5	6	7	8
2	3	A	U	X	X	0	1

Board/Department/Programme/Course Type			
Character Type – Alphabet			
AD	Artificial Intelligence & Data Science	ME	Mechanical
AM	CSE (Artificial Intelligence & Machine Learning)	SC	CSE (Cyber Security)
AU	Automobile	PH	Physics
CE	Civil	CH	Chemistry
CS	Computer Science	EN	English
EA	Advanced Communication Technology	MA	Mathematics
EC	Electronics and Communication	ES	Employability Skills
EE	Electrical and Electronics	VA	Value Added Course
EV	VLSI Design & Technology	SA	Studio Activities
IT	Information Technology		

Programme: B.E. Electronics and Communication (Advanced Communication Technology)
2023 Regulations
Curriculum for Semester I to VIII
(2023 Batch only)

Course Category	Course Code	Course Title	Duration	Credits	Marks
VAC	23VAL101	Induction Program	3 Weeks	-	100

Semester I

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
AEC	23ENI101	Communication Skills I	2	0	2	3	100	All
Minor	23MAI102	Matrices and Calculus	3	0	2	4	100	AU,EA,EC, EE,EV&ME
Major	23ECT101	Electron Devices	3	0	0	3	100	EA,EC&EV
Major	23ECT001	Circuit Theory	3	0	0	3	100	EA,EC&EV
Multi-disciplinary	23ADT001	C Programming	3	0	0	3	100	CE,EA,EC & EV
Major	23ECL001	Electric Circuits and Electron Devices Laboratory	0	0	3	1.5	100	EA,EC&EV
Multi-disciplinary	23ADL001	C Programming Laboratory	0	0	3	1.5	100	CE,EA,EC &EV
VAC	23VAL102	Wellness for Students	0	0	2	1	100	All
VAC	23VAT101	தமிழர் மரபு/Heritage of Tamils	1	0	0	1	100	All
AEC	23SAL101	Studio Activities	0	0	2	-	-	All
		Total	15	0	14	21	900	

Semester II

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
AEC	23ENI201/ 23FLT201/ 23FLT202	Communication Skills II/ Foreign Language –Japanese/ Foreign Language - German	2 3 3	0 0 0	2 0 0	3	100	All
Minor	23MAI204	Linear Algebra and Complex Variable	3	0	2	4	100	--
Minor	23PHI201	Physics for Electrical Sciences	3	0	2	4	100	EA,EC,EE & EV
Major	23EAI201	Digital Principles and System Design	3	0	2	4	100	--
Multi-disciplinary	23ITT202	Problem Solving and Python Programming	3	0	0	3	100	EA,EC & EV
Multi-disciplinary	23MEL001	Engineering Drawing	1	0	3	2.5	100	AD,AM,AU,CS, EA,EC,EE,EV,IT, ME & SC
SEC	23ESL201	Professional Skills 1:Problem solving skills & Logical Thinking 1	0	0	2	1	100	All
VAC	23VAT201	தமிழரும் தொழில்நுட்பமும்/ Tamils and Technology	1	0	0	1	100	All
Multi-disciplinary	23CHT202	Environmental Sciences	1	0	0	-	100	All
AEC	23SAL201	Studio Activities	0	0	2	-	-	All
		Total	17	0	15	22.5	900	

Passed in 4th Board of Studies Meeting held on 09.05.2025
Approved in 20th Academic Council Meeting held on 04.07.2025

BOS Chairman

Semester III

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Minor	23MAT304	Probability Theory for Communication Engineers	3	1	0	4	100	--
Major	23EAT301	Electronic Circuits	3	0	0	3	100	--
Major	23EAT302	Analog Communication	3	0	0	3	100	--
Major	23ECT002	Transmission Lines and Waveguides	3	0	0	3	100	EA & EC
Multi-disciplinary	23ITI001	Data Structures using C	3	0	2	4	100	EA & EC
Major	23EAL301	Electronic Circuits Laboratory	0	0	3	1.5	100	--
SEC	23ESL301	Professional Skills 2: Problem solving skills & Logical Thinking 2	0	0	2	1	100	All
VAC	23VAT301	Universal Human Values 2 :Understanding Harmony	2	1	0	3	100	All
AEC	23SAL301	Studio Activities	0	0	2	-	-	All
		Total	17	2	9	22.5	800	

Semester IV

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Minor	23MAT402	Numerical methods and optimization	3	1	0	4	100	--
Major	23EAT401	Antenna Design Technologies	3	0	0	3	100	--
Major	23EAT402	Microcontroller and its applications	3	0	0	3	100	--
Major	23EAT403	Digital Communication	3	0	0	3	100	--
Major	23EAT404	CMOS VLSI design	3	0	0	3	100	--
Major	23EAL401	Analog and Digital Communication Laboratory	0	0	3	1.5	100	--
Major	23EAL402	Microcontroller Laboratory	0	0	3	1.5	100	--
SEC	23ESL401	Professional Skills 3: Professional Development and Etiquette	0	0	2	1	100	All
AEC	23SAL401	Studio Activities	0	0	2	-	-	All
		Total	15	1	10	20	800	

Course Category	Course Code	Course Title	Duration	Credits	Marks
SEC	23XXXXXX	Internship -1/Community Internship /Skill Development	2 Weeks	1	100

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BOS Chairman

Semester V

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EAI501	Signal Processing for Communication	3	0	2	4	100	--
Major	23EAT501	Microwave and optical communication	3	0	0	3	100	--
Major	23EAT502	Wireless Communication	3	0	0	3	100	--
Major	23EAL501	Microwave and Optical Communication Laboratory	0	0	3	1.5	100	--
Major	23XXXXXX	Professional Elective - I	3	0	0	3	100	--
Major	23XXXXXX	Professional Elective - II	3	0	0	3	100	--
SEC	23ESL501	Professional Skills :4 Communication Skills and Interview Essentials	0	0	2	1	100	All
Project	23EAP501	Reverse Engineering Project	0	0	6	3	100	--
AEC	23SAL501	Studio Activities	0	0	2	-	-	All
Total			15	0	15	21.5	800	

Semester VI

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EAT601	Software Defined Radio	3	0	0	3	100	--
Major	23EAT602	MIMO and OFDM techniques	3	0	0	3	100	--
Major	23XXXXXX	Professional Elective - III	3	0	0	3	100	--
Major	23XXXXXX	Professional Elective - IV	3	0	0	3	100	--
Minor	23XXXXXX	Open Elective - I	3	0	0	3	100	--
Major	23EAL601	Software Defined Radio Laboratory	0	0	3	1.5	100	-
Major	23EAL602	MIMO and OFDM laboratory	0	0	3	1.5	100	-
SEC	23ESL601	Professional Skills 5: Ace and Elevate : Aptitude and Soft Skills	0	0	2	1	100	All
AEC	23SAL601	Studio Activities	0	0	2	-	-	All
Total			15	0	10	19	800	

Course Category	Course Code	Course Title	Duration	Credits	Marks
SEC	23XXXXXX	Internship - 2/ Research Internship/ Skill Development	2 Weeks – 4 Weeks	1	100

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BOS Chairman

Semester VII

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EAT701	5G Communication Technologies	3	0	0	3	100	--
Major	23EAT702	RF Circuit Design	3	0	0	3	100	--
Major	23EAT703	Millimeter wave communication	3	0	0	3	100	--
SEC	23EAL701	RF Circuit Design Laboratory	0	0	3	1.5	100	--
Major	23XXXXXX	Professional Elective - V	3	0	0	3	100	--
Major	23XXXXXX	Professional Elective - VI	3	0	0	3	100	--
Minor	23XXXXXX	Open Elective - II	3	0	0	3	100	--
Project	23EAP701	Project Phase - I	0	0	8	4	100	--
		Total	18	0	11	23.5	800	

Semester VIII

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Project	23EAP801	Project Phase - II	0	0	12	6	200	--
SEC	23XXXXXX	Internship - 3/ Skill Development	8 Weeks			4	100	--
		Total	0	0	12	10	300	

Total Credits: 162

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BOS Chairman

VERTICALS

Networking Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE001	Cryptography and Network Security	3	0	0	3	100	EA,EC
23ECE002	Wireless Networks	3	0	0	3	100	EA,EC
23ECE004	Cyber forensics and Information Security	3	0	0	3	100	EA,EC
23ECE005	High Speed Networks	3	0	0	3	100	EA,EC
23ECE006	Data Communication Networks	3	0	0	3	100	EA,EC
23EAE001	Bluetooth Technology	3	0	0	3	100	-

RF Communication Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE007	Electromagnetic Interference and Compatibility	3	0	0	3	100	EA,EC
23ECE010	Ultra wideband communication	3	0	0	3	100	EA,EC
23ECE011	RF Transceivers	3	0	0	3	100	EA,EC
23ECE012	Cognitive Radio Network	3	0	0	3	100	EA,EC
23EAE002	Error Control Coding Techniques	3	0	0	3	100	-
23EAE003	Electromagnetic Metamaterials	3	0	0	3	100	-

VLSI Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE020	Low Power VLSI Design	3	0	0	3	100	EA,EC
23ECE021	ASIC Design	3	0	0	3	100	EA,EC

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23ECE022	CMOS Analog IC Design	3	0	0	3	100	EA,EC
23ECE023	FPGA based System Design	3	0	0	3	100	EA,EC
23ECE024	Testing of VLSI Circuits	3	0	0	3	100	EA,EC
23EAE004	Verilog Modeling and Verification	3	0	0	3	100	-
23EAE005	VLSI for wireless communication	3	0	0	3	100	-

Signal Processing Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE025	Digital Image and Video Processing	3	0	0	3	100	EA,EC
23ECE026	Speech and Audio Signal Processing	3	0	0	3	100	EA,EC
23ECE027	Wavelets and Its Applications	3	0	0	3	100	EA,EC
23ECE028	Multirate signal processing	3	0	0	3	100	EA,EC
23ECE029	Biomedical Image and Signal Processing	3	0	0	3	100	EA,EC
23ECE030	Computer Vision	3	0	0	3	100	EA,EC

Embedded systems and IoT Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE031	Embedded Programming	3	0	0	3	100	EA,EC
23ECE032	Advanced Microprocessor and Microcontroller	3	0	0	3	100	EA,EC
23ECE033	Embedded Real Time systems	3	0	0	3	100	EA,EC
23ECE034	MEMS Design	3	0	0	3	100	EA,EC
23ECE035	IoT Based System Design	3	0	0	3	100	EA,EC
23ECE036	Industrial IoT and Industry 4.0	3	0	0	3	100	EA,EC
23EAE006	Embedded Networking and Automation	3	0	0	3	100	-

Computing Technologies Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE037	JAVA Programming	3	0	0	3	100	EA,EC,EE
23ECE038	Big Data analytics and Cloud Computing	3	0	0	3	100	EA,EC,EE
23ECE039	Cryptocurrency and Block Chain Technologies	3	0	0	3	100	EA,EC
23ECE040	Neural Networks and Deep Learning	3	0	0	3	100	EA,EC
23ECE041	Augmented Reality and Virtual Reality	3	0	0	3	100	EA,EC
23ECE042	Web Programming	3	0	0	3	100	EA,EC
23AME037	Computational Quantum Mechanics	3	0	0	3	100	AM,EA,EC
23EAE007	Machine Learning	3	0	0	3	100	-

Diversified Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECE051	Computer Architecture	3	0	0	3	100	EA,EC,EV
23ECE052	Linux Programming and Shell Scripting	2	0	2	3	100	EA,EC
23EEE014	Industrial Automation	3	0	0	3	100	EA,EC,EE,EV
23EEE085	Automotive Electronics	3	0	0	3	100	EA,EC,EE,EV
23MEE008	PLM for Engineers	2	0	2	3	100	All
23MEE030	Principles of Management	3	0	0	3	100	EA,EC,EE,EV,ME
23AUE051	Design Thinking and Innovation	3	0	0	3	100	All
23SCE050	Cyber Security	3	0	0	3	100	AD,AM,AU,CE,EA,EC,EE,EV,ME
23ITE047	Intellectual Property Rights	3	0	0	3	100	All
23AUE050	Entrepreneurship Development	3	0	0	3	100	All

Open Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23ECO001	Consumer Electronics	3	0	0	3	100	-
23ECO002	Artificial Intelligence	3	0	0	3	100	-
23ECO003	In-Vehicle Networking	3	0	0	3	100	-
23ECO004	Data Science for Engineering	3	0	0	3	100	-
23ECO005	Internet of Everything	3	0	0	3	100	-
23ECO006	Machine Vision System	3	0	0	3	100	-
23ECO007	Soft Computing	3	0	0	3	100	-

Passed in 4th Board of Studies Meeting held on 09.05.2025
Approved in 20th Academic Council Meeting held on 04.07.2025

BOS Chairman

SEMESTER I

Course Code:23VAL101		Course Title: Induction Program (Common to all B.E/B.Tech Programmes)	
Course Category: VAC		Course Level: Introductory	
Duration: 3 weeks	Mandatory Non-Credit Course	Max Marks:100	

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Explain various sources available to meet the needs of self, such as personal items and learning resources
2. Explain various career opportunities, opportunity for growth of self and avenues available in the campus
3. Explain the opportunity available for professional development
4. Build universal human values and bonding amongst all the inmates of the campus and the society.

List of Activities:

1. History of Institution and Management: Overview on NIA Educational Institutions – Growth of MCET – Examination Process –OBE Practices –Code of Conduct – Centre of Excellence.
2. Lectures, interaction sessions and Motivational Talks by Eminent people, Alumni, Employer and Industry Experts
3. Familiarisation of Department / Branch:HoD's & Senior Interaction- Department Associatio
4. Universal Human Value Modules : Aspirations and concerns, Self Management, Relations Social and Natural Environment.
5. Orientation on Professional Skills Courses
6. Proficiency Modules : Mathematics, English, Physics and Chemistry
7. Introduction to various Chapters, Cells, Clubs and its events
8. Creative Arts : Painting, Music and Dance
9. Physical Activity :Games, Sports and Yoga
10. Group Visits: Visit to local area and Campus Tour

Course Outcomes	Cognitive Leve
At the end of this course, students will be able to:	
CO1 : Explain various sources available to meet the needs of self, such as personal items and learning resources through visit to local areas and campus	Understand
CO2: Explain various career opportunities and avenues available in the campus through orientation sessions	Understand
CO3: Explain the opportunity available for professional development through professional skills, curricular, co-curricular and extracurricular activities	Understand
CO4: Build universal human values and bonding amongst all the inmates of the campus and society for having a better life	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO2	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO3	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO4	2	-	-	-	-	-	-	2	1	2	-	-	-	-

High : 3, Medium :2, Low: 1

Text Book(s):

T1. Reading material, Workbook prepared by PS team of the college

Reference Book(s):

R1. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster Uk, 2004.

R2. Vethathiri Maharishi Institute For Spiritual and Intuitional Education, aliyar, “value educat harmonious life (Manavalakalai Yoga)”, Vethathri Publications, Erode, 2010.

R3. Dr.R.Nagarathna, Dr.H.R. Nagendra, “ Integrated approach of yoga therapy for positive Swami Vivekananada Yoga Prakashana Bangalore,2008 Ed.

Web References:

1. https://youtube.com/playlist?list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKznV
2. https://www.youtube.com/watch?v=P4vjfEVk&list=PLWDeKF97v9SO0frdgmpaghDMjkom1
3. https://fdp-si.aicte-india.org/download/AboutSIP/About%20SIP.pdf

Course Code: 23ENI101	Course Title: Communication Skills I (Common to all B.E/B.Tech Programmes)		
Course Category: AEC		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:2	Credits: 3	Total Contact Hours:60	Max Marks:100

Course Objectives

The course is intended to impart formal and informal language effectively and accurately in various real-life contexts on par with B1 level of CEFR Scale.

Module I **20 Hours**

Grammar: Synonyms & Antonyms -Tense forms - Modals - Passives – Reported Speech – Comparatives and Descriptive adjectives.

Listening: Listening for gist and specific information - Listening to past events, experiences and job preferences - Listening to descriptions of monuments - Listening for excuses - Listening to description: transportation systems and public places.

Speaking: Introducing oneself - Exchanging personal information – Effective Conversations: Role Play Situations (Describing personality traits - Describing landmarks, monuments and festivals - Making polite requests and excuses - Discussing facts - Asking for and giving information – Expressing wishes - Talking about lifestyle changes - Talking about transportation and its problems - Describing positive and negative features of things and places - Making comparisons)

Reading: Skimming and Scanning - Reading Comprehension - Reading and comprehending online posts and emails – Case Studies

Writing: Letter writing (Permission letters - Online cover letter for job applications) - Instructions - Recommendations - Write a blog (General) - Report Writing (Industrial Visit Report and Event Reports) - formal and informal emails.

Module II **20 Hours**

Grammar: Sequence adverbs - Phrasal verbs - Relative clauses – Imperatives - Infinitives - Conditionals.

Listening: Listening to review of food items - Listening to results of surveys- Listening to motivational talks & podcasts

Speaking: Expressing likes and dislikes - Describing a favourite snack - Giving advices and suggestions - Speculating about past and future Events – Group Discussion

Reading: Reading different expository texts - Reading to factual texts - Print and online media- Reading Comprehension

Writing: Process Descriptions – Email Writing (Requesting for information) - Reviewing Movie – Social media feeds/posts (Any Social Media)

List of Experiments: **20 Hours**

1. Mini Presentation and Picture Prompt Discussion
2. Debate Tournament
3. Listening, Mind Mapping & Summarization
4. Listening to Stories and Providing the Innovative Climax
5. Reading Comprehension
6. Writing - Interpretation of Visuals

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1 : Utilize the basic English grammar and vocabulary to acquire professional communication skills.	Apply
CO 2 : Develop listening and speaking skills through classroom activities based on listening comprehension, recapitulation, interpretation and debate on the same	Apply
CO 3 : Read and write social media posts and comments	Apply
CO 4 : Perform as a member of a team and engage in individual presentation	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s book 2”, 5thEdition, Cambridge University Press, South Asia Edition, 2022.

T2. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s Book 1”, 5thEdition, Cambridge University Press, South Asia Edition, 2022.

Reference Book(s):

R1. David Bohlke, Jack C. Richards, “Four Corners”, 2nd Edition, Cambridge University Press,2018.

R2. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Graham Burton,Empower B1 – Student’s Book, Cambridge University Press, 2020.

R3. Raymond Murphy, “Intermediate English Grammar” 30th Edition, Cambridge University Press,2022.

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

Course Code: 23MAI102		Course Title: Matrices and Calculus (Common to AU, EA, EC, EE, EV & ME)	
Course Category: Minor		Course Level: Introductory	
L:T:P(Hours/Week) 3:0 :2	Credits: 4	Total Contact Hours:75	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the use of matrix algebra techniques for practical applications, familiarize with differential calculus and acquire knowledge of mathematical tools to evaluate multiple integrals.

Module I **23 Hours**

Matrices

Definitions and examples of symmetric, skew symmetric and orthogonal matrices - Eigenvalues and Eigenvectors – Properties of Eigenvalues and Eigenvectors-Diagonalization of matrices through orthogonal transformation - Cayley-Hamilton Theorem (without proof) – verification problems and properties - Transformation of quadratic forms to canonical forms through orthogonal transformation.

Differential and Integral Calculus

Curvature – Radius of curvature –Centre of curvature- Circle of curvature - Evolutes and Involutes - Evaluation of definite and improper integrals - Beta and Gamma functions – Properties and applications.

Multivariable Differentiation I

Limit – continuity - Mean value theorems and partial derivatives - Taylor's series and Maclaurin's series – Jacobian of functions of several variables.

Module II **22 Hours**

Multivariable Differentiation II

Maxima, Minima and saddle points of functions of several variables - Method of Lagrange's multipliers.

Multiple Integral

Multiple Integration: Double integrals - Change of order of integration in double integrals - Change of variables (Cartesian to polar, Cartesian to spherical and Cartesian to cylindrical) - Triple integrals - Applications: Finding areas and volumes.

Ordinary Differential Equations Of Second and Higher Orders

Second and higher order linear differential equations with constant coefficients – Second order linear differential equations with variable coefficients (Cauchy - Euler equation, Legendre's equation) – Method of variation of parameters – Solution of first order simultaneous linear ordinary differential equations

List of Experiments: **30 Hours**

1. Introduction to MATLAB.
2. Rank of matrix and solution of system of linear algebraic equations.
3. Finding Eigen values and Eigen vectors of a matrix.
4. Solving ordinary differential equation.
5. Gram Schmidt Procedure.
6. Finding Maxima, Minima of a function.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the canonical form of a quadratic form using orthogonal transformation.	Apply
CO2: Identify the evolute of a curve and solve the improper integrals using beta gamma functions.	Apply
CO3: Examine the extreme value of multivariate functions.	Apply
CO4: Evaluate the area and volume using multiple integrals and solve the higher order differential equations.	Apply
CO5: Demonstrate the understanding of calculus concepts through modern tools.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 9th edition, John Wiley& Sons, 2006.

T2. Veerarajan T., Engineering Mathematics for first year, 3rd edition, Tata McGraw-Hill,

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th edition, Pearson, Reprint, 2002.

R2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

R3. P. Sivaramakrishna Das , C. Vijayakumari , Engineering Mathematics, Pearson India, 2017.

Passed in 01st Board of Studies Meeting held on 11.1.2024
Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Web References:

1. https://nptel.ac.in/courses/111107112
2. https://nptel.ac.in/courses/111104031

Course Code: 23ECT101		Course Title: Electron Devices (Common to EA ,EC & EV)	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to impart knowledge of basic electronic devices such as diodes, Bipolar junction Transistors and Field effect transistors.

Module I **23 Hours**

Semiconductor Diode: PN junction - forward and reverse bias conditions. V-I Characteristics and its Temperature dependence – Diode specifications - Diode Resistance – Diode junction Capacitance – Transition and Diffusion capacitances - Rectifiers - Clipper - Clamper

Special Diodes: Zener diode - Characteristics of Zener diode - Avalanche and Zener breakdown - Application of Zener diode :Voltage regulator - Varactor diode, Tunnel diode, Light emitting diodes – Photo diodes

Bipolar Junction Transistors: Bipolar Junction Transistor and its types: NPN and PNP Transistor - Transistor operation - Configurations of BJT : Input and output characteristics of CE, CB and CC configurations - Transistor as a Switch and Amplifier.

Module II **22 Hours**

Field Effect Transistors: JFET and its types, construction and operation of n- channel and p-channel JFETs – characteristics curves – FET applications – Comparison of BJT and JFET

MOSFETS and Power Devices: MOSFETs: Depletion MOSFETs and Enhancement MOSFETs – construction and operation - Drain and Transfer characteristics - Differences between JFETs and MOSFETs – Precaution in handling MOSFETs - MOSFET as a switch.

Construction, operation and characteristics of SCR, DIAC, TRIAC, Power transistor and IGBT

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand and explain the construction and characteristics of PN junction diode, special diodes, BJTs, FETs and Power devices.	Understand
CO 2: Identify a suitable electronic device and develop appropriate circuit for the given application.	Analyze
CO 3: Engage in independent study as a member of a team and make an effective oral presentation on the applications of various Electron devices.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	1	1	-

High-3; Medium-2; Low-1

Text Book:

T1. Millman J. , Halkias C. C. "Electronic Devices and Circuits ", Tata McGraw Hill, New Delhi, 2011.

Reference Book(s):

R1. Salivahanan.S, Suresh kumar.N and Vallavaraj.A, “Electronic Devices and Circuits”, Second Edition, TMH, New Delhi, 2008.

R2. Robert Boylestad and Louis Nashelsky, “Electron Devices and Circuit Theory”, Pearson Prentice Hall, Tenth Edition, 2008.

R3. Streetman Ben G. and Banerjee Sanjay, “Solid State Electronic devices”, PHI, Sixth Edition, 2006

R4. David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth Edition, 2008

Web References:

1. http://nptel.ac.in/video.php?subjectId=117103063
2. http://nptel.ac.in/video.php?subjectId=117106091
3. www.youtube.com/watch?v=Wf19II0ts84

Course Code: 23ECT001		Course Title: Circuit Theory (Common to EA ,EC&EV)	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to impart knowledge of the fundamentals of Electric circuits and its analysis.

Module I **23 Hours**

Fundamentals of Electric Circuits: Ohm's law - Kirchoff's Laws –Series resistive circuit- Voltage division rule- Parallel resistive circuit – Current division rule– Source transformation – Star to delta and delta to star transformation

Time period, Frequency, Angular frequency, Average value, Root mean square value, Form factor and Peak factor of sinusoidal.

Analysis of DC and AC Circuits: Mesh and node method of analysis - Networks theorem: Superposition Theorem , Thevenin's Theorem, Norton's theorem and Maximum power transfer theorem.

Module II **22 Hours**

Resonance and Coupled Circuits: Series resonance-Voltage and Current in a series resonance, Impedance and phase angle. Parallel resonance-Resonant frequency - Variation of Impedance with frequency Coupled circuits- mutual inductance, Coefficient of coupling.

Transient Response of Networks: Steady state and Transient response - Response of an R-L, R-C and R-L-C circuits under DC excitation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Define, understand, and explain the various laws for analyzing Electric circuits.	Understand
CO2: Apply the knowledge of network laws and theorems to the given electric circuit to obtain the required parameters.	Apply
CO3: Analyze the resonance and transient behaviour of the given electric circuit using appropriate mathematical tools.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1.Sudhakar A, Shyammohan S. Pillai "Circuits and Networks -Analysis and Synthesis", McGraw Hill., New Delhi, 2015

Reference Book(s):

R1. William H. Hayt and Jack E. Kemmerly, “Engineering Circuit Analysis ", McGraw Hill International Edition, 2006

R2. Singh "Network Analysis and Synthesis", McGraw-Hill Education., New Delhi, 2013

R3. M. Arumugham and N.Prem kumar, “Electric Circuit Theory”, Khanna publishers, 2010

R4. Alexander C, Sadiku M. N. O "Fundamentals of Electric Circuits", Tata McGraw Hill., New Delhi, 2013

Web References:

1. http://nptel.ac.in/video.php?subjectId=108102042
2. http://nptel.ac.in/courses/108102042/
3. http://nptel.ac.in/courses/108105053/
4. http://freevideolectures.com/Course/2336/Circuit-Theory/

Course Code: 23ADT001		Course Title: C Programming (Common to CE,EA,EC , & EV)	
Course Category: Multi-disciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course helps to understand the structured and procedural programming skills. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition using complex data types.

Module I **22 Hours**

Basics Of Computer Organization: Generation and Classification of Computers – Basic Organization of a Computer **—** Softwaredevelopment life cycle – Problem Solving Techniques, Algorithm, Pseudo code and Flow Chart.

Introduction To C Programming: Introduction – Structure of a C program – Keywords – Identifiers – Constants – Variables – Data Types – Operators and Expressions – Formatted & Unformatted I/O functions – Decision statements – Loop control statements.

Arrays: Characteristics – Declaration- One-dimensional array, Two-dimensional arrays

Module II **23 Hours**

Functions: Declaration & Definition of function – Built in function – User defined function -Types of functions – Call by value & reference.

Strings and Pointers: Formatting strings – String handling functions. Pointers: Features and Types of pointers – Arithmetic operations with pointers–Pointers and Arrays- Array of Pointers-Pointers and Strings

Structures and Union: Structures: Features – Operations on Structures – Array of structures – Pointers to Structures -Unions-Union of Structures.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Correlate the fundamental concepts of computer organization such as architectures of the processors and project management for real time application	Apply
CO2: Infer the fundamental concepts of programming, such as variables, data types and control structures for real time problems	Analyze
CO3: Apply programs solving skills and knowledge of C programming constructs to solve the given one dimensional and two dimensional datasets	Apply
CO4: Build a modules to solve the given application using functions	Apply
CO5: Develop a program by accessing the address of the variable using pointers and manipulation of characters using string handling functions	Apply
CO6: Test the performance of the students by group assignments and projects on real time problems	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	2	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	1	-	-	-	-	-	-	-	-	-
CO5	3	-	-	1	-	-	-	-	-	-	-	-
CO6	-	1	-	3	2	-	-	-	2	-	-	2

High-3; Medium-2; Low-1

Text Book(s):

T1. Ashok N.Kamthane, Amit.N.Kamthane, “Programming in C”, 3rd Edition,Pearson Education, 2015.

T2. Deitel H M and Deitel P J, “C How to Program”, Prentice Hall, 2013.

Reference Book(s):

R1. Ajay Mittal, “Programming in C-A Practical Approach”, 3rd Edition, Pearson Education, 2010.

R2. Yashavant P.Kanetkar,” Let Us C” , 16th Edition, BPB Publications, 2018.

R3. Herbert Schildt, “C The Complete Reference", Tata McGraw Hill, 2010.

R4. S Gottfried Byron, “Programming With C”, Tata McGraw Hill, 2011.

Web References:

1. NPTEL course content on Introduction To Programming In https://onlinecourses.nptel.ac.in/noc22_cs40
2. Complete guide on Learn C programming: http://www.cprogramming.com/
3. Complete reference manual on C programming: http://www.c4learn.com/

Course Code: 23ECL001	Course Title: Electric Circuits and Electron Devices Laboratory (Common to EA, EC & EV)		
Course Category: Major		Course Level: Introductory	
L:T:P (Hours/Week) 0:0:3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to verify the electric circuit, network theorems and characteristics of the basic electronic devices.

List of Experiments:

1. PN Junction Diode and Zener diode Characteristics
2. Half wave and Full wave Rectifier circuits
3. Regulator using Zener diode
4. Wave shaping circuits: Clippers and clampers
5. Characteristics of Common Emitter configuration
6. Characteristics of Common Base configuration
7. FET characteristics and its application as a switch
8. Verification of Kirchhoff's Voltage and Current laws
9. Verification of Super Position Theorem
10. Verification of Thevenin's and Norton's theorems
11. Verification of Maximum Power transfer theorem
12. Determination of Resonance frequency of Series & Parallel RLC Circuits

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Conduct experiments to verify the characteristics of devices and theorems for Electric circuits.	Evaluate
CO2: Compare the experimental results obtained during verification of network theorems with simulation results.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	3	-	-	-	-	1	1	-	-	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	1	1	-

High-3; Medium-2; Low-1

Reference:

1. Laboratory Manual Prepared by Faculty of Electronics and Communication Engineering, Dr. Mahalingam College of Engineering and Technology.

Passed in 01st Board of Studies Meeting held on 11.1.2024
Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Code:23ADL001	Course Title: C Programming Laboratory (Common to CE,EA,EC,&EV))		
Course Category: Multi-disciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 0:0:3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives

The course introduces students to the practical knowledge of programming using C programming language as an implementation tool. It aims at providing students with understanding of programming essentials used within the framework of imperative and structural programming paradigms.

List of Experiments:

1. Implement basic C programs using data types
2. Implement programs using Operators and Expressions
3. Develop Programs using Branching statements
4. Implement Programs using Control Structures
5. Develop programs using Arrays
6. Implement programs using Functions
7. Implement programs using String Operations
8. Develop programs using Pointers
9. Implement programs using Structures
10. Develop programs using Union

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Write programs using appropriate programming constructs.	Apply
CO2: Apply programs solving skills and knowledge of C programming constructs to solve the given one dimensional and two dimensional dataset	Apply
CO3: Develop a program by accessing the address of the variable using pointers and manipulation of characters using string handling functions	Analyze
CO4: Evaluate modular programming techniques to break down complex programs into smaller and manageable modules	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	3	-	-	-	-	-	-	-
CO2	3	-	-	-	3	-	-	-	-	-	-	-
CO3	-	2	-	-	3	-	-	-	-	-	-	-
CO4	-	-	-	3	3	-	-	-	-	-	-	1

High-3; Medium-2; Low-1

Text Book(s):

T1. Ashok N.Kamthane,Amit.N.Kamthane, “Programming in C”, 3rd Edition, Pearson education, 2015.

T2. Deitel H M and Deitel P J, “C How to Program”, Prentice Hall, 2013.

Reference Book(s):

R1. Ajay Mittal, “Programming in C-A Practical Approach”, 3rd Edition, Pearson Education, 2010.

R2. Yashavant P.Kanetkar, “Let Us C”, 16th Edition, BPB Publications, 2018.

R3. Herbert Schildt, “C The Complete Reference", Tata McGraw Hill, 2010.

Web References:

1. C programming resources: https://electronicsforu.com/resources/15-free-c-programming-ebooks
2. C programming tutorials: https://www.fromdev.com/2013/10/c-programming-tutorials.html
3. C Manual: https://books.goalkicker.com/CBook

Course Code: 23VAL102		Course Title: Wellness for Students (Common to all B.E/B.Tech Programmes)	
Course Category: VAC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0 :2	Credits:1	Total Contact Hours:30	Max Marks:100

Course Objectives:
The course is intended to impart knowledge on setting SMART goals for academic, career and life, applying time management techniques, articulating the importance of wellness for success in life and understanding the dimensions of wellbeing and relevant practices.

Module I **15 Hours**

GOAL SETTING Understanding Vision and mission statements - Writing personal mission statements – 'Focus' as a way of life of most successful people. Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume. Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment.

TIME MANAGEMENT - TOOLS AND TECHNIQUES Importance of planning and working to time. Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying 'NO' – Managing procrastination.

CONCEPT OF WELLNESS – impact of absence of wellness - Wellness as important component to achieve success. Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods

Module II **15 Hours**

Simplified Physical Exercises. Fitness as a subset of Wellness – health related physical fitness - skill related physical fitness. Joint movements, Warm up exercises, simple asanas, WCSC simplified exercises.

PRACTICES FOR MENTAL WELLNESS

Meditation: Mind and its functions - mind wave frequency – Simple basic meditation – WCSC meditation and introspection tables. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.
Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) – hazards of junk food - food and the gunas.

PUTTING INTO PRACTICE
Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Set well-articulated goals for academics, career, and personal aspirations	Apply
CO 2: Apply time management techniques to complete planned tasks on time	Apply
CO 3: Explain the concept of wellness and its importance to be successful in career and life	Apply
CO 4: Explain the dimensions of wellness and practices that can promote wellness	Apply
CO 5: Demonstrate the practices that can promote wellness	Valuing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	1	-	1
CO2	-	-	-	-	-	-	-	-	1	-	1	1
CO3	-	-	-	-	-	-	-	-	1	-	-	1
CO4	-	-	-	-	-	-	-	-	1	-	-	1
CO5	-	-	-	-	-	1	1	-	1	-	-	1

High-3; Medium-2;Low-1

Text Book(s):

T1. Reading material, workbook and journal prepared by PS team of the college

Reference Book(s):

R1. Stephen R Covey, “First things first”, Simon & Schuster UK, Aug 1997

R2. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster UK, 2004.

R3. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, “Value education for harmonious life (Manavalakalai Yoga)”, Vethathiri Publications, Erode, I Ed. (2010).

R4. Dr. R. Nagarathna, Dr. H.R. Nagendra, “Integrated approach of yoga therapy for positive health”, Swami Vivekananda Yoga Prakashana, Bangalore, 2008 Ed.

R5. Tony Buzan, Harper Collins, “The Power of Physical Intelligence English”

Course Code: 23VAT101	Course Title: HERITAGE OF TAMILS (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்ள இயலும்.

CO.2இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்ள இயலும்.

தமிழர் மரபு

அலகு 1 – மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு 2 – மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு 3 – நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு 4 – தமிழர்களின் திணைக் கோட்பாடுகள் **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக் கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு 5 – இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு **3**

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறபகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுய மரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப் படிகள்– தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
மாணவர்கள் இப்பாடத்தை கற்றபின்	
CO.1 மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2 இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code: 23VAT101	Course Title: HERITAGE OF TAMILS (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.
2. Understand the Contribution of Tamils to Indian National Movement and Indian Culture.

HERITAGE OF TAMILS

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS **3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS **3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE **3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO.1 Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.	Understand
CO.2 Understand the Contribution of Tamils to Indian National Movement and Indian Culture.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Passed in 01st Board of Studies Meeting held on 11.1.2024
Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

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9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER II

Course Code: 23ENI201		Course Title: Communication Skills II (Common to all B.E/B.Tech Programmes)	
Course Category: AEC		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:2	Credits: 3	Total ContactHours:60	Max Marks:100

Course Objectives

The course is intended to impart effective and accurate language in business correspondence on par with B2 level of CEFR Scale.

20 Hours

Module I

Grammar: Linking Words - Collocations –Sentence Completion - Articles –Adverbs– Indefinite Pronoun

Listening: Listening to short conversations - Listening for gist and summarizing - Listening for detail - Responding to straightforward questions.

Speaking: Making statements of facts - Agreeing and disagreeing to opinions - Respond to queries - Group Discussion.

Reading: Read and select (phrasal verbs & relative clause)- Cloze Test - Gapped sentences - Multiple- choice gap-fill

Writing: Paragraph Writing: Descriptive, narrative, persuasive and argumentative - Emails: Giving information - Making enquiries - Responding to enquiries - Power Point Presentation

Module II **20 Hours**

Grammar: Expressions of cause and result – Concord - Error Spotting (Parts of Speech & Indian English) - Prepositions

Listening: Listening for identifying main points - Responding to a range of questions about different topics - Listening to identify relevant information

Speaking: Empathetic Enunciation – Situation handling – Visual Interpretation - - Short presentations

Reading: Intensive Reading: Comprehending business articles, reports and proposals and company websites-- Open gap-fill - Extended reading

Writing: – Report Writing - Memo – Complaint letter - Business Letters (Seeking permission & Providing Information)

List of Experiments: **20 Hours**

1. Listening to Monologue and Extended Listening Activity I
2. Listening to Monologue and Extended Listening Activity II
3. Expressing Opinions and Situational based speaking
4. Mini Presentation and Visual Interpretation
5. Reading Comprehension
6. Writing letter, email and report

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Identify the common errors in written and spoken correspondence.	Apply
CO2: Develop listening, reading and speaking skills through task based activities in listening, reading comprehension, recapitulation, interpretation and discussion.	Apply
CO3: Read business correspondences like memo, Email, letter, proposals and write reports and website entries and product launches.	Apply
CO4: Perform as an individual and member of a team and engage effectively in group discussion and individual presentation.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Guy Brook- Hart, "Business Benchmark Upper Intermediate", 2nd Edition, South Asian, Cambridge University Press, 2020.

T2. Norman Whitby, "Business Benchmark pre-intermediate to Intermediate", 2nd Edition, South Asian, Cambridge University Press, 2014.

Reference Book(s):

R1. Hewings Martin - Advanced Grammar in use Upper-intermediate Proficiency, CUP,3rd Edition,2013.

R2. Clark David – Essential BULATS (Business Language Testing Service), CUP, 2006.

R3. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Rachel Godfrey,Gareth Davies, Empower B1+ – Student's Book, Cambridge University Press,2015.

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

Course Code:23FLT201		Course Title: FOREIGN LANGUAGE -JAPANESE (Common to all B.E/B.Tech Programmes)	
Course Category: AEC		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course Objectives:

The course objectives intended to:

1. Express a basic exposure on Japanese language and culture
2. Express thoughts and communicate in the beginner level of Japanese with native Japanese speaker
3. Identify the kanji etymology as well as use it in basic vocabulary required for the JLPT/NAT 5 examination level
4. Read and write 100 kanji of the official JLPT N5
5. Choose the appropriate verb forms for learning and practicing the Japanese language

UNIT I Introduction to Japan and greetings 9 Hours

Japan : Land and culture - Introduction to Japanese language – Greetings – Seasons - Days of the week - Months of the year – Dates of the month - Self introduction – Numbers (Upto 99,999) – Expressing time – Conversation audio and video.

Listening: Listening to Greetings - Listening for Specific Information: Numbers, Time. Speaking: Self-Introduction

UNIT II Building vocabulary 9 Hours

Family relationships - Colours - Parts of body - Profession - Directions - Time expressions (today, tomorrow, yesterday, day before, day after) - Japanese housing and living style - Food and transport (vocabulary) - Stationery, fruits and vegetables

Listening: Listening for Specific Information: Directions, Family Members, Parts of body Speaking: Introducing one's family.

UNIT III Writing systems 9 Hours

Hiragana Chart 1 - vowels and consonants and related vocabulary – Hiragana Charts 2&3, double consonants, vowel elongation and related vocabulary – Introduction to Kanji – Basic Vocabulary – Basic Conversational Phrases.

Listening: Listening to Japanese Alphabet Pronunciation, Simple Conversation.

Speaking: Pair Activity (Day to day situational conversation)

UNIT IV Kanji and preposition 9 Hours

Katakana script and related vocabulary – Basic kanjis: naka, ue, shita, kawa , yama , numbers (1- 10, 100, 1000, 10,000 and yen) , person, man, woman, child, tree , book , hidari, migi, kuchi , 4 directions - Usage of particles wa, no, mo and ka and exercises - Usage of kore, sore, are, kono, sono, ano, arimasu and imasu - Particles – ni (location) and ga , donata and dare - Particles ni (time), kara, made , ne , koko, soko, asoko and doko - Directions : kochira, sochira, achira and dochira , associated vocabulary (mae, ushiro, ue, shita, tonari, soba, etc.)

Listening: Listening to conversation with related particles

UNIT V Verb forms 9 Hours

Introduction to Verbs - Verbs –Past tense, negative - i-ending and na-ending adjectives introduction - ~masen ka, mashou - Usage of particles de, e , o, to, ga(but) and exercises - Adjectives (present/past – affirmative and negative) – Counters - ~te form

Listening: Listening to different counters, simple conversations with verbs and adjectives.

Speaking: Pair Activity (Explaining one's daily routine by using appropriate particles and verbs)

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Recognize and write Japanese alphabet	Understand
CO2:	Comprehend the conversation and give correct meaning	Understand
CO3:	Apply appropriate vocabulary needed for simple conversation in Japanese language	Apply
CO4:	Apply appropriate grammar to write and speak in Japanese language	Apply
CO5:	Speak using words of the Japanese language	Apply

Text Book:

T1. Genki 1 Textbook: An Integrated Course in Elementary Japanese by Eri Banno, Yoko Ikeda, Yutaka Ohno, Yoko Sakane, Chikako Shinagawa, Kyoko Tokashiki published by The Japan Times

T2. Genki 1 Workbook: An Integrated Course in Elementary Japanese by Eri Banno published by The Japan Times

Reference:

1. *Japanese for Everyone: Elementary Main Textbook1-1*, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007
2. *Japanese for Everyone: Elementary Main Textbook1-2*, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007
3. www.japaneselifestyle.com
4. www.learn-japanese.info/

5. www.learn.hiragana-katakana.com/typing-hiragana-characters/
6. www.kanjisite.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2; Low-1

Course Code:23FLT202	Course Title: FOREIGN LANGUAGE - GERMAN (Common to all B.E/B.Tech Programmes)		
Course Category: AEC		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course Objectives:

The course is intended to:

1. Listen and understand numbers, names and dialogues of a native speaker on par with A1 level.
2. Speak and introduce self in simple sentences to convey their opinion and ideas on par with A1 level.
3. Read simple passages and given text on par with A1 level.
4. Write letter and simple sentences on par with A1 level.

UNIT I BASIC INTRODUCTION TO GERMAN SCRIPTS 9

Theme and Text (Introduction to German - German script, Deutsche Namen, Daily Greetings and Expressions) – Grammar ('wh' questions, das Alphabet)– Speak Action (Buchstabieren, sich und andere vorstellen nach Namen und Herkunft fragen, internationale Wörter auf Deutsch verstehen, jemanden begrüßen)– pronunciation (Buchstabieren J,V,W,Y, - Long vowels A,E,I,O,U - Pronunciation of Ä,Ü,Ö) – To learn (internationale Wörter in Texten finden, Wörter sortieren)

Theme and Text (Gespräche im caf'e, Getränkekarte, Telefon-buch, Namen, Rechnungen) – Grammar (Frägesatze mit wie, woher, wo, was Verben in präsens Singular und Plural, das Verb Sein, Personalpronomen und Verben)– Speak Action (eine Gespräch beginnen sich und andere vorstellen zählen, etwas bestellen und bezhalen Telefonnummern und verstehen)– pronunciation (Wortakzent in Verben und in Zahlen) – To learn (Grammatiktabelle ergänzen, mit einem Redemittelkasten arbeiten)

UNIT II NUMBERS AND NOMINATIVE CASE 9

Theme and Text (Numbers – 1 to 12 (Eins bis Zwolf) – 20, 30, 40, 90 (zwanzig-Neunzig) – All Numbers (1-10000) – German Currency (Euro) – Basic Mathematics (plus, Minus, Malen, Geteilt durch)) – Grammar (Introduction of verbs –Have Verb – To Come, To Speak, To Read, To Drive, To Fly, To write, To Eat, To sleep, To take etc.,)

Theme and Text (Communication in course) – Grammar (Singular and Plural, Artikel: der,das,die/ ein,eine, verneinung: kein, keine, Komposita: das Kursbuch) – Speak Action (Gegenständen

fragen/ Gegenstände benennen im kurs:) – pronunciation (word accent Marking, Umlaute ö ä ü hören und sprechen) – To learn (Lernkarten schreiben, Memotipps, eine Regel selbst finden)

Theme and Text (City, Town, Language: Nachbar, Sprachen, Sehenswürdigkeiten in Europa) – Grammar (Past tense for Sein, W-Frage, Aussagesatz und Satzfrage) – Speak Action (about city and siteseeing) – pronunciation (Satzakzent in Frage- und Aussagesätzen) – To learn (eine Regel ergänzen, eine Grammatiktabelle erarbeiten, Notizen machen)

UNIT III AKKUSATIVE CASE AND PREPOSITIONS 9

Theme and Text (Menschen und Hauser, Furniture catalogue, E-Mail, House information) – Grammar (possesivartikel im Nominativ, Artikel im Akkusativ, Adjektive im satz, Graduierung mit zu)– Speak Action (Whonung bescreiben about perons and things)– pronunciation (consonant - ch) – To learn (wortschatz systematisch)

Theme and Text (Termine - Appointment and punctuality in Germany) – Grammar (questions with wann?, Preposition (am, um, von... bis), verneinung mit nicht, trennbare verben, präteritum von haben) – Speak Action (Daily plan making, time commitment, excuse for late coming) – pronunciation (consonants- p,b,t,d / k,g) – To learn (Rollenkarten arbeiten)

Theme and Text (orientation in working area, go for work, floor plan city plan, office and computer) – Grammar (preposition: in,neben, unter, auf, vor, hinter, an, zwischen, bei und mit + Datic)– Speak Action (work place, work, giving appointments)– pronunciation (consonants: f,w und v) – To learn (Making notice in calender)

UNIT IV DATIV CASE AND PREPOSITIONS 9

Theme and Text (Holiday and Party, holiday plan, party plan in Germany) – Grammar (regular and iregular verbs) – Speak Action (holiday speak, accident, Ich-Text schreiben) – pronunciation (lange und kurze vokale markieren) – To learn (Text Order)

Theme and Text (organising an Excursion to Berlin through city orientation, Bus plan, City plan, post card, Excursion programme) – Grammar (preposition: in, durch, über + Akkusativ: zu, an... vorbei + Dativ, Modalverb wollen) – Speak Action (Tourism, culture, postcard preparation, travel description) – pronunciation (r and l)– To learn (plaket making)Theme and Text (Beruf und all Tag, Visiten karten, wörterbuch) – Grammar – Speak Action (profession, statistic speaking) – pronunciation (n,ng and nk)– To learn (wörterbuch , text information in tabel)

UNIT V ADJECTIVES AND PRONUNCIATION 9

Theme and Text (Haushaltstipp, kochrezept, maße und gewichte, Mahlzeiten und Gerichte) – Grammar (jeden Tag, manchmal, nie, Question - welche, Comparison – viel, gut, gern) – Speak Action (about eat, drink question and answers) – pronunciation (e,en,el,er) – To learn (Text auswerten und zusammenfassen)

Theme and Text (Clothing , colour, weather) – Grammar (Adjecktive im Akkusativ, unbestimmer Artikel) – Speak Action (weather, dress and colour understanding) – pronunciation (e-o- ö and ie-u- ü) – To learn (wetter and Farben interkulturelle)

Theme and Text (in super market,purchase, House Maintainence, Emotion, Sports, Body parts) – Grammar (Modal Verb) – Speak Action (Body parts) – To learn (Rollenkarten arbeiten)

Total:45 Hours

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	Recognize and write German alphabet, numbers.	Understand
C02	. Comprehend the conversation and give correct meaning	Understand
CO3	Apply appropriate grammar and vocabulary to write and speak.	Apply
CO4	Apply appropriate cases and texts to listen, write and speak.	Apply
CO5	Speak and read using words of the German language	Apply

TEXT BOOK

T1. Netzwerk, "Deutsch als Fremdsprache" by Stefanie Dengler, Paul Rusch, Helen Schmitz published

T2. Funk, Kuhn, Demme, "Studio D A1 Deutsch als Fremdsprache" published by Goyal Publishers & Distributors Pvt Ltd;

REFERENCES

R1. Hueber, "Fit for Goethe- Zertifikat A1 (Start Deutsch 1)" by GOYAL PUBLISHERS AND DISTRIBUTORS; 2016

Course Articulation Matrix

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**
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2;Low-1

Course Code: 23MAI204		Course Title: Linear Algebra and Complex Variables	
Course Category: Minor		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 2	Credits: 4	Total Contact Hours: 75	Max Marks: 100

Course Objectives:

This course is intended to enable the student to acquire the knowledge on the linear algebra and calculus of functions of complex variables.

Module I **23 Hours**

Systems of linear algebraic equations

System of linear algebraic equations - Gaussian elimination, Gauss Jordan methods and LU factorizations - permutation matrix - Inverse matrices by Gauss Jordan method.

Vector spaces

Euclidean space and vector space - subspace – linear combination – span - linearly independent and dependent - bases – dimensions - Finite dimensional Euclidean space.

Subspace Properties

Row and column spaces -Rank and nullity – Bases for subspace – inevitability- Application in interpolation.

Module II **22 Hours**

Complex Variables (Differentiation)

Cauchy – Riemann equation – Analytic function – Properties – Harmonic function – Finding harmonic and harmonic conjugate – Conformal mapping (w=z+a, w=1/z) – Mobius transformation and their properties.

Complex Variables (Integration)

Cauchy Integral formula – Cauchy Integral theorem – Taylor's series – Singularities of analytic function – Laurent's series – Residues – Cauchy Residue theorem – Contour integrals – Evaluation of real definite integrals around unit circle and semi-circle (Excluding poles on the real axis)

List of Experiments(Using Python): **30 Hours**

1. Compute the solution of system of linear equations using Gauss elimination method.
2. Compute inverse of a matrix.
3. Check the linear independency and orthogonality between vectors.
4. Find the basis and dimension of row space, column space and null space of a given set of vectors.
5. Compute arithmetic operations using complex() function.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the concepts of matrices and system of linear equations using decomposition methods and concept of vector spaces and subspaces.	Apply
CO2: Compute the basis and dimension of sub spaces, row and column space.	Apply
CO3: Use the concepts of complex variables to construct analytical function.	Apply
CO4: Use the concepts of complex integration to evaluate definite integrals.	Apply
CO5: Develop programs using Linear Algebra and Complex Variables concepts through modern tool.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. David C Lay, Linear Algebra and its Applications, 3rd Edition, Pearson Education, 2009.

T2. Erwin Kreyzig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2015.

Reference Book(s):

R1. K. Hoffman and R. Kunze, Linear Algebra, Pearson, 2015.

R2. Gilbert Strang, Linear Algebra and its Applications, 3rd, Harcourt College Publishers, 2005.

R3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2014.

Web References:

1. https://nptel.ac.in/courses/111106051
2. https://www.classcentral.com/course/matrix-algebra-engineers-11986

Course Code: 23PHI201		Course Title: Physics for Electrical Sciences (Common to EA, EC, EE & EV)	
Course Category: Minor		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 2	Credits: 4	Total Contact Hours:75	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the fundamental laws and relations in electricity, magnetism, electromagnetism and electromagnetic waves.

Module I **22 Hours**

Electrostatics: Definition of electric charge-Coulomb's Law – Electric field intensity – Field intensity due to point and line charges – Electric flux density -Gauss's law- Application of Gauss's law: Determine the field due to a line charge and a plane sheet of charge – Electric potential-Equipotential surfaces-Potential gradient.

Magnetostatics: Definition of magnetic flux- magnetic field intensity-Lorentz Law of force- Biot – Savart law, Ampere's Law- Application of Ampere's Law: Magnetic induction due to a long linear conductor and solenoid - Magnetic field due to straight conductors-circular loop – Magnetic flux density (B) - Magnetic potential.

Electric Fields in Materials: Dielectrics: An atomic view - Dielectric Polarization-Dielectrics and Gauss's law- Dielectric Strength- Energy stored in a dielectric medium - Capacity of a condenser - Capacitance - coaxial, Spherical capacitor- Poisson and Laplace Equation.

Module II **23 Hours**

Magnetic Fields in Materials: Magnetic susceptibility and permeability- properties of dia, para and ferro magnetic materials-hysteresis loop.

Electromagnetic Induction: Faraday's law – Lenz's law – Time varying magnetic field - self Inductance - self Inductance of a solenoid- Mutual inductance- Mutual inductance of two solenoids. Charge conservation law - continuity equation- displacement current-Maxwell's equations.

Electromagnetic Waves: Electromagnetic waves in free space - Poynting vector - Propagation of electromagnetic waves in dielectrics – Phase velocity- Propagation of electromagnetic waves through conducting media- penetration or skin depth.

List of Experiments (Any six) **30 Hours**

1. Verification of Ohms' law.
2. Test the Faraday's hypothesis of magnetic field induction.
3. Determination of specific resistance of the given material using Carey foster's bridge.
4. Measurement of capacitance using Schering Bridge.
5. Measurement of inductance using Maxwell Bridge.
6. Determination of wavelength of the given light source using spectrometer.
7. Determination of Dielectric constant of a given Material.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: **Apply** the concepts of static electric and magnetic fields to obtain the electric and magnetic characteristics of the materials.	Apply
CO2: **Interpret** the behavior of materials in electric and magnetic fields.	Apply
CO3: **Apply** the concept of time-varying electric and magnetic fields to obtain the propagation characteristics of electromagnetic waves in different media.	Apply
CO4: **Conduct, analyze and interpret** the data and results from the physics laboratory experiments.	Evaluate

Course Articulation Matrix

CO Vs PO	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
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. R.K.Gaur and S.L.Gupta, “Engineering Physics”, Dhanpat Rai publications, New Delhi, 8th Edition, 2011.

T2. W. H. Hayt and John A. Buck, “Engineering Electromagnetics”, Tata McGraw Hill, New Delhi, 6th Edition, 2014.

Reference Book(s):

R1. David Griffiths, “Introduction to Electrodynamics”, Pearson Education, 4th Edition, 2013

R2. K. A. Gangadhar and P. M. Ramanathan, “ Electromagnetic Field Theory”, Khanna Publishers, New Delhi, 5th Edition, 2013.

R3. Mathew. N. O. Sadiku, “Elements of Electromagnetics”, Oxford University Press, 4th Edition, 2009.

Web References:

1. http://nptel.iitm.ac.in
2. http://openems.de/start/index.php
3. https://bop-iitk.vlabs.ac.in/List%20of%20experiments.html

Course Code: 23EAI201		Course Title: Digital Principles and System Design	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:2	Credits:4	Total Contact Hours:75	Max Marks:100

Course Objectives:
The course is intended to impart knowledge on the design of combination and sequential digital circuits

Module I **22 Hours**

Number System: Review of decimal, binary, octal and hexadecimal numbers – Complements: 1's and 2's – Arithmetic operation of Signed binary numbers - Digital Logic Gates – Universal gate Implementation.

Boolean algebra: Basic Theorems, properties and– Representation of Boolean functions in Canonical and standard forms

Minimization Techniques: Simplifications of Boolean expression using 3 and 4 variable K map method and Mc-Cluskey method.

Logic Families: Characteristics and operation of TTL, ECL, CMOS logic.

Combinational Circuits: Design Procedure of adder-half adder, full adder,4-bit RCA, Subtractor: half subtractor, full subtractor,4-bit subtractor, Comparator: 4-bit magnitude comparator, code converters-binary to excess-3,binary to gray,Encoders-8 to 3, Decoders- 3 to 8, Multiplexers-8 X 1 and De-multiplexers-1 X 8.

Module II **23 Hours**

Synchronous Sequential Logic

Flip flops: SR, JK, T, D – Level and Edge Triggering – Analysis of sequential circuits - Design of sequential circuits– **Registers:** Shift registers – SISO, SIPO, PISO, PIPO –**Counters:** Design of 3-bit synchronous and ripple counter.

Asynchronous Sequential Logic

Analysis of Asynchronous Sequential Circuits - Design of Asynchronous Sequential Circuits with primitive flow table, state reduction and state assignment – Races, Cycles and Hazards: Static, Dynamic, Essential, Hazards elimination.

List of Experiments: **30 Hours**

1. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters.
2. Design and implement Half/Full Adder and Subtractor.
3. Design and implement combinational circuits using MSI devices: Parity generator / checker, Application using multiplexers
4. Design and implement shift-registers.
5. Design and implement synchronous counters.
6. Design and implement asynchronous counters.
7. Self-study: Verilog HDL

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Understand number system and Boolean algebra.	Understand
CO2:Design and implement various combinational circuits using various minimization techniques.	Apply
CO3:Analyze a given requirement and design a hazard free Sequential circuit.	Analyze
CO4:Participate in individual study and make an oral presentation as a team on HDL concepts.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-	2	2
CO3	-	3	-	-	-	-	2	-	-	-	-	-	2	2
CO4	-	-	-	-	-	-	-	-	2	-	-	2	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd,2002

T2. Donald D. Givone, “Digital Principles and Design”, McGraw-Hill , 2003

Reference Book(s):

R1. John F. Wakerly ,”Digital Design : Principles and Practices”, 4th Edition, Pearson education,2008

R2. Charles Roth Jr , Eugene John, Larry Kinney ”Fundamental of Logic Design” Enhanced Edition, CL Engineering,2020

R3. Samir Palnitkar,” Verilog HDL: A Guide to Digital Design and Synthesis”, 2nd Edition, Pearson India,2003

Web References:

1. https://nptel.ac.in/courses/117105080
2. https://www.tutorialspoint.com/digital_circuits/index.htm
3. https://www.circuitlab.com/

Course Code: 23ITT202		Course Title: Problem solving and Python Programming (Common to EA, EC & EV)	
Course Category: Multidisciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The objective of the course is to introduce learners to the fundamentals of programming using the Python language. The course aims to equip participants with the necessary skills and knowledge to write efficient, readable, and maintainable Python code.

Module I **23 Hours**

Basics of Python: Features - Variables and Data Types - Expressions and Statements - Operators.

Control Flow: Conditional Statements – Looping and Iterative Statements

Functions and File Handling: Introduction to Functions - Recursive Functions - Introduction to Files and File Handling

Data Structures in Python: Lists: Functions and Methods - Tuples: Operations and Built-in Functions - Sets: Functions and Methods - Dictionaries: Functions and Methods - Strings: Operators and Built-In String Functions

OOP Concepts: Classes and Objects: Modifiers in Classes - Method Invocation in Classes - Inheritance and Polymorphism.

Module II **22 Hours**

Exception Handling: Errors and Exceptions

GUI Programming with TKinter: GUI Basics - Working with the TKinter Library

Widgets and Events: Adding Widgets and Binding Events - Message and Entry Widgets - Checkboxes and Radio Buttons - Menus and Lists - Canvas for Drawing

Data Visualization with Matplotlib: Introduction to Matplotlib Library - Line and Bar Plots - Scatter Plots - Pie Charts - Working with Multiple Figures - 3D Plots - Plotting Using Files.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply Python programming constructs and data structure techniques to solve practical problems and build functional applications.	Apply
CO2: Categorize the OOPs concepts to create modular and extensible Python programs.	Analyze

CO3: Infer the errors and exceptions in Python programs using exception handling techniques to ensure robust and fault-tolerant code	Analyze
CO4: Build graphical user interfaces (GUIs) using TKinter, effectively incorporating various widgets and event binding to create interactive and visually appealing applications	Apply
CO5:. Employ the Matplotlib library for data visualization to present data and insights in a visually impactful method	Apply
CO6: Combine the Python language features and libraries to provide solutions collaboratively with Ethical values to the practical problems	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	3	2	2	-	-	3	3	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey, and Chris Meyers, “How to Think Like a Computer Scientist: Learning with Python”,3rd Edition, O’Reilly, 2020.

T2. Mark Lutz, “Powerful Object-Oriented Programming Python”, 4th Edition, O’Reilly, 2013.

Reference Book(s):

R1. Mark Lutz, “Learning Python, Powerful OOPs”, 5th Edition, O’Reilly, 2013.

R2. Zelle, John M, “Python Programming: An Introduction to Computer Science”, Franklin Beedle& Associates, 2003.

Web References

1. https://docs.python.org/3/tutorial/
2. https://www.learnpython.org/
3. https://www.pyschools.com/
4. https://archive.nptel.ac.in/courses/106/106/106106182/

Course Code: 23MEL001		Course Title: ENGINEERING DRAWING (Common to AD,AM,AU,CS,EA ,EC,EE,EV,IT,ME, SC)	
Course Category: Multidisciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to

- To impart knowledge on basic dimensioning. 2D and 3 D drawings such as points, lines, planes and solids on first quadrant.

Module I **8 Hours**

Basics of Engineering Drawing: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Basic Geometrical constructions –Orthographic projection- Free hand Sketching.

Projection of Points, Lines: First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces by rotating object method.

Projection of Solids: Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination).

Module II **7 Hours**

Sectioned Solids: Sectioning of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by cutting planes inclined to one reference plane and perpendicular to the other – Orthographic views of sections of simple solids.

Development of Surfaces: Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders using straight line and radial line method.

Isometric Projection: Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids. Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination).

List of Experiments **45 Hours**

1. Lettering & Dimensioning
2. Projection of Points & Lines
3. Orthographic projections
4. Projection of Simple Solids
5. Projection of Section of Simple Solids
6. Development of Surfaces
7. Isometric Projections

Course Outcomes:

CO 1: Apply the concepts related to free hand sketching, orthographic and Isometric projection in first quadrant.	Understand
CO2: Apply the concepts and draw projections of points in four different quadrants and lines located first quadrant.	Apply
CO3: Apply the concepts and draw projections and sections of simple solids using rotatingobject method.	Apply
CO4: Apply the concepts and draw lateral surface of simple solids using straight line andradial line development methods.	Apply
CO5: Apply the concepts and draw isometric view of simple solids and truncated solids using principles of isometric projection.	Apply
CO6: Conduct experiments to demonstrate concepts, implement and analyze the drawing concepts using engineering tool : Using AutoCAD.	Analyze

Textbook:

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, " Engineering Drawing and Design", Tata McGraw Hill India, New Delhi, 3rd edition, 2019.

Reference Book(s):

R1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill India, New Delhi, 2nd edition, 2014.

R2. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD" Tata McGraw India, New Delhi, 3rd edition, 2010.

R3. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, Gujarat, 54rd edition, 2023.

PUBLICATIONS OF BUREAU OF INDIAN STANDARDS

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
2. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
3. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods. The mode of delivery is like practical.

Web References:

1 http://nptel.ac.in/courses/112103019/

2 https://www.coursera.org/specializations/autodesk-cad-cam-cae-mechanical-engineering

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	3	-	-	3	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 23ESL201		Course Title: Professional Skills 1: Problem solving skills & Logical Thinking 1 (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

To enhance the students' numerical, analytical and logical reasoning ability.

To make them prepare for various public and private sector exams and placement drives.

Module I Quantitative Ability 20 Hours

Number System and LCM & HCF- Percentage- Ratio and Proportion - Average- Progressions- Ages-Partnership- Mixture & Allegation - Profit and loss- Interest calculation- Data interpretation.

Module II Reasoning Ability 10 Hours

Seating Arrangement- Linear, circular and Complex – Direction Problems- Blood Relation- Puzzles- Crypt arithmetic- Venn diagrams- Statement and conclusion- Statement and argument- Causes and effects- Self-Learning.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Build the competence in numerical, analytical and logical Reasoning ability	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Passed in 01st Board of Studies Meeting held on 11.1.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Textbook(s):

T1: Dr. R. S. Aggarwal. “Quantitative Aptitude for Competitive Examinations” Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

T2: Dr. R. S. Aggarwal. “A Modern Approach to Logical Reasoning”, Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018

Reference Book(s):

R1: R. V. Praveen. “Quantitative Aptitude and Reasoning” 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd, 2013

R2: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition, 2020

R3: Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Course Code: 23VAT201	Course Title: TAMILS AND TECHNOLOGY (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்ள இயலும்.

CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்ள இயலும்.

தமிழரும் தொழில்நுட்பமும்

அலகு 1 – நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு 2 – வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் ஷ சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள், பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ – சாரோசெனிக் கட்டிடக் கலை.

அலகு 3 – உற்பத்தித் தொழில்நுட்பம் 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு 4 வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன் வளம் – முத்து மற்றும் முத்துக் குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு 5 – அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி – கணினித் தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென் பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
மாணவர்கள் இப்பாடத்தை கற்றபின்	
CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code: 23VAT201		Course Title: TAMILS AND TECHNOLOGY (Common to all B.E/B.Tech Programmes)	
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.
2. Understand the Scientific Tamil & Tamil Computing.

TAMILS AND TECHNOLOGY

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO.1 Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.	Understand
CO.2 Understand the Scientific Tamil & Tamil Computing.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code: 23CHT202		Course Title: Environmental Sciences (Common to all B.E/B.Tech Programmes)	
Course Category: Multidisciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 0	Credits: Mandatory Non-Credit Course	Total Contact Hours: 15	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on sustainable utilization of natural resources, prevention of pollution, disaster management and environmental issues & public awareness on ecosystem.

Module I **8 Hours**

Natural Resources

Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

Environmental Pollution and Disaster Management

Role of an individual in prevention of pollution; Disaster management : floods, earthquake, cyclone and landslides.

Environmental Ethics and Legislations

Environmental ethics : Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation.

Module II **7 Hours**

Environmental Issues and Public Awareness

Public awareness - Environment and human health.

Environmental Activities

(a) Awareness Activities:

i. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste.
ii. Slogan making event.
iii. Poster making event.

(b) Actual Activities:

i. Plantation.
ii. Cleanliness drive.
iii. Drive for segregation of waste.
iv. To know about the different varieties of plants.
v. Shutting down the fans and ACs of the campus for an hour or so.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Explain the use of natural resources for a sustainable life as an individual in prevention of pollution.	Understand
CO 2: Apply the environmental ethics and legislations for various environmental issues.	Apply
CO 3: Create the public awareness on environment and human health as an individual or team through various activity based learning.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	3	3	-	-	-	-
CO3	3	-	-	-	-	3	3	-	3	3	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Benny Joseph, "Environmental Studies", Tata McGraw Hill, New Delhi, 2006.

T2. Mackenzie Davis and Susan Masten, "Principles of environmental engineering and science", Mc-Graw Hill, 3rd Edition, 2014.

Reference Book(s):

R1. Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol.I and II, Enviro Media.

R2. Cunningham, W.P.Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publishing House, Mumbai, 2001.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview.
2. https://en.wikipedia.org/wiki/Environmental_science.

SEMESTER III

Course Code: 23MAT304		Course Title: Probability Theory for Communication Engineers	
Course Category: Minor		Course Level : Intermediate	
L:T:P(Hours/Week) 3:1 :0	Credits: 4	Total Contact Hours:60	Max Marks:100

Course Objectives:

This course aims at providing the student to acquire the knowledge on probability theory and random variables and probability distributions.

Module I **22+8 Hours**

Probability Theory: Definition of Probability – Axiomatic definition of Probability – Addition theorem of Probability – Conditional Probability – Multiplication theorem of Probability – Baye‟s Theorem (Statement only) – Related Problems.

Random Variables: Random Variable- Probability distribution function - Probability density function – Cumulative distribution function – Properties- Moments- Moment generating functions and their properties - Two Dimensional random variable – Joint distributions – Marginal and conditional distributions- Independence of random variable. Covariance – Correlation and its properties - Spearman's Rank correlation- Regression - Transformation of random variables.

Module II **23+7 Hours**

Discrete Distributions: Bernoulli Distribution – Binomial Distribution – Poisson Distribution– Geometric Distribution - Properties- M.G.F, mean and variance.

Continuous Distributions: Normal Distribution – Properties – Uniform Distribution – Exponential Distribution – Gamma Distribution – Beta Distribution- Central limit theorem M.G.F, mean and variance.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate the probability concepts to solve communication engineering problems.	Understand
CO2: Construct probability models and function of random variables based on discrete and continuous random variables.	Apply
CO3: Apply the knowledge of correlation and regression to identify the relationship between two variables.	Apply
CO4: Relate the concept of probability distributions to solve real life problems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	1	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Veerajan T, “Probability, Statistics and Random process”, 3rd Edition, Tata McGraw-Hill,New Delhi, 2017.

T2. Dr.J.Ravichandran, “Probability and Statistics for Engineers”, 1stEdition, Wiley IndiaPvt. Ltd., 2010.

Reference Book(s):

R1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, “Probability and Statistics for Engineersand Scientists”, 9th Edition Pearson Education, Asia, 2013.

R2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, “Schaum's Outlines Probability and Statistics”, 4th Edition Tata McGraw Hill edition, 2012.

R3. Morris DeGroot, Mark Schervish, “Probability and Statistics”, Pearson Educational Ltd, 4th Edition, 2014.

Web References:

1 https://archive.nptel.ac.in/courses/111/105/111105090/

2. https://archive.nptel.ac.in/courses/111/105/111105041/

Course Code: 23EAT301		Course Title: Electronic Circuits	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on fundamental concepts of electronic circuits and its design procedure.

Module I **23 Hours**

BJT and FET amplifiers: Biasing techniques for BJT and FET - fixed bias and voltage divider bias. Analysis of CE Amplifier using h-parameter model. Hybrid π model of CE amplifier. Large Signal Amplifiers: Class A, Class B and Class C amplifiers. Feedback and Tuned amplifiers: Types of Feedback- Feedback amplifiers: Voltage series, Current series, current shunt and voltage shunt. Single tuned amplifier–Neutralization techniques.

Module II **22 Hours**

Applications of Op-amp and Special function ICs: Ideal Op-amp characteristics and its equivalent circuit –DC characteristics - AC characteristics –Inverting and Non-inverting amplifier - Instrumentation Amplifier. Oscillators and Multivibrators: RC phase shift Oscillator using OP-AMP - LC oscillators using BJT: Hartley and Colpitt's oscillator - Astable multivibrator, Monostable multivibrator and Bistable multivibrator. Special function ICs and its applications: IC 555 timer - IC 565 PLL.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Define and Explain various terms and characteristics of Electronic Circuits	Understand
CO2 Apply the concept of network theorems to analyze the input and output parameters of electronic circuits.	Apply
CO3: Identify and Analyze Electronic Circuits for the given specifications	Analyze
CO4: Design Electronic circuits using appropriate Electronic components for the given application.	Analyze
CO5: Develop a simple mini-project using suitable Electronic components and demonstrate as a team or individual (for internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	3	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	-	-	-	-	1	1	-	1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Anil K.Maini and Varsha Agarwal, “Electronic Devices and Circuits”, Wiley India Pvt. Ltd, New Delhi, 2009.

T2. D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., Fifth Edition, 2018.

Reference Book(s):

R1.S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, “Electronic Devices and Circuits”, Second Edition, Tata McGraw-Hill, New Delhi, 2007.

R2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016

R3. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.

Web References:

1. https://www.ee.iitm.ac.in/videolectures/doku.php?id=ec201
2. https://nptel.ac.in/courses/117101106
3. https://onlinecourses.nptel.ac.in/noc24_ee73/preview

Course Code: 23EAT302		Course Title: Analog Communication	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) : 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on various modulation techniques, noise in communication systems and to characterize the information by quantitative theory

Module I **22 Hours**

Amplitude Modulation systems-Need for modulation, Amplitude Modulation–time domain and frequency domain description – AM power distribution – DSBSC,SSB,VSB. Generation of AM waves: DSBSC(Balanced modulator)– SSB(Phase shift method), Detection of AM waves: Super heterodyne Receiver, Frequency Division Multiplexing.

Angle Modulation systems - Phase Modulation - Frequency Modulation-Narrow band and wideband FM, Generation of FM waves: Direct Method-Indirect Method-Detection of FM waves: Balanced slope detector - Foster Seeley discriminator - Ratio detector -Phase locked loop. Analysis of AM and FM signals using simulation tools.

Module II **23 Hours**

Random Process-Random variables, Central limit Theorem, Random Process, Stationary Processes, Mean, Correlation and Covariance functions, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random Process Through a LTI filter.

Noise characterization-Noise sources and types – Signal to noise ratio - Noise figure and noise temperature – Noise in cascaded systems–Noise performance in AM systems
Noise performance in FM systems – Pre-emphasis and de-emphasis –Capture effect and threshold effect

Information Theory - Uncertainty, Information and entropy, source coding theorem, Discrete Memory less channels, Mutual Information, Channel capacity, Channel coding theorem, Differential entropy, Information capacity theorem

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Demonstrate the amplitude, frequency and phase modulation systems and compute the transmission efficiency .	Apply
CO 2: Experiment AM and FM using MATLAB or any other relevant tools (for internal assessment only)	Analyze
CO 3: Analyze the Random Process in Communication systems. Prepare an oral presentation collaboratively as a team.	Analyze
CO 4 : Compare the noise performance of AM and FM systems and formulate the methods to reduce noise interference	Analyze
CO 5: Examine the various information theories in communication systems	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	3	-	-	-	-	-	-	-	2	-
CO3	-	1	-	-	-	-	-	-	3	3	-	-	2	-
CO4	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Simon Haykin, “Communication Systems”, John Wiley and Sons, Inc, 4th Edition, 2010

T2.George Kennedy, Bernard Davis, “Electronic Communication Systems”,

Tata McGraw-Hill, 4th Edition, 2008

Reference Book(s):

R1.Wayne Tomasi, “Electronic communication systems”, Prentice Hall of India Ltd., New Delhi, 2004.

R2.Taub and D. Schilling, Gautam Sahe, “Principles of Communication Systems”, TMH, 3rd Edition, 2007.

R3.Frenzel, Louis E., Jr., “Principles of Electronic Communication Systems”,4thEdition, McGraw-Hill, 2008

Web References:

1. https://onlinecourses.nptel.ac.in/noc19_ee46/preview
2. https://www.tutorialspoint.com/analog_communication/index.htm
3. https://t.ly/NoRIh

Course Code: 23ECT002		Course Title: Transmission Lines and Waveguides (common to EA and EC)	
Course Category : Major		Course Level: Intermediate	
L:T:P (Hours/Week): 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

Empower students with essential skills in transmission line networks, power measurement, impedance matching, and expertise in waveguide propagation modes and cavity resonators for RF and Microwave applications.

Module I **22 Hours**

Basics of Transmission Lines: Concept and definition, Different kinds of transmission lines, Applications, Equivalent circuit, Primary and Secondary constants –General transmission line equations- Transmission line Parameters -The lossless transmission line, The infinite long transmission line, The distortion less transmission line and condition for distortion less and minimum attenuation

High Frequency Transmission Lines: Approximations at high frequencies - Line of zero dissipation - Voltage and current on the dissipation-less line, Standing Waves, Standing Wave Ratio - Input impedance of the dissipation-less line - Open and short-circuited lines - Power and impedance measurement on lines

Impedance matching: Quarter wave transmission line, Single stub matching, Construction of smith chart, Smith chart as impedance chart, smith chart as admittance chart, single stub matching Problems using smith chart - Impedance matching network design using smith chart utility in ADS software.

Module II **23 Hours**

Waveguides: Introduction, Wave propagation in parallel plane waveguide, Rectangular Waveguides-Transverse Electric (TE) and Transverse Magnetic (TM) mode analysis – Field expressions, Characteristic equation, Cut-off frequency, Phase velocity, Group velocity, Wavelength and Impedance, Dominant and degenerate modes

Cavities and Planar transmission lines: Rectangular Cavity Resonators-Dominant modes and Resonant Frequencies, Q factor, Unloaded Q for TE_{101} mode, Types of coupling and Coupling coefficients.

Losses in transmission lines - Strip Lines, Micro strip Lines, Slot lines, Coplanar lines

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the analytical and graphical tool such as smith chart for the transmission line problems and impedance calculations	Apply
CO 2: Analyze the transmission line characteristics at microwave frequency range under various load conditions.	Analyze
CO 3:Design waveguides and microstrip lines for a given specification	Apply
CO4: Integrate through independent or team learning and employ modern tools for the design of transmission lines and impedance matching networks (for internal assessments only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CO4	-	3	-	-	3	-	-	-	3	3	-	-	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. John D Ryder, “Networks, Lines and Fields”, PHI, 2nd Edition New Delhi, 1999.
T2. Jordan. E.C. and Balmain.K.G, “Electromagnetic Waves and Radiating Systems”, 2nd Editon, PHI, New Delhi, 1995.

Reference Book(s):

R1. R.K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill India, 2005
R2. Umesh Sinha, “Transmission Lines and Networks”, Satya Prakashan (Tech. India Publications, New Delhi), 2001
R3. David M. Pozar, “Microwave Engineering”, 3rd Edition, John Wiley, 2009.

Web References:

1. https://nptel.ac.in/courses/117101057
2. https://www.microwaves101.com/encyclopedias/transmission-lines
3. http://www.amanogawa.com/archive/transmissionB.html

Course Code: 23ITI001		Course Title: Data Structures using C (Common to EA,EC)	
Course Category: Multidisciplinary		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Course Objectives:

The objective of this course is to impart knowledge of fundamental data structures and its implementation. Additionally, learn the application of data structures for solving various problems.

Module I **23 Hours**

Linked List: Introduction- Types of Data Structures - Abstract Data type, List ADT: Array Implementation of list - Linked List Implementation of list – Doubly Linked List – Circularly Linked List-Applications: Radix sort, Stack ADT: Stack Model – Array and Linked List Implementation of Stack Applications: Balancing Symbols - Postfix Expressions- Infix to Postfix Conversion, Queue ADT: Queue Model – Array and Linked List Implementation of Queue-Double ended Queue- Applications of Queue

Module II **22 Hours**

Trees: Implementation of Trees - Tree Traversals ,Binary Trees: Implementation – Expression Trees – Binary Search Tree: Implementation, AVL Trees: Single Rotation – Double Rotation – Implementation, Graphs: Definitions – Representation of Graphs – Graph Traversals: Breadth First Search –Depth First Search -Topological Sort ,Weighted and Unweighted Shortest Path Algorithms: Dijkstra's Algorithm - Breadth-First Search Algorithm, All Pairs Shortest Path: Floyds Algorithm, Minimum Spanning Tree: Prim's Algorithm – Krushkal's Algorithm ,Internal Sorting: Insertion Sort-Merge Sort-Quick Sort-Bucket Sort.

List of Exercises: **30 Hours**

1. Implementation of List ADT using array and Linked list
2. Implementation of Stack ADT and Queue ADT in array
3. Implementation of Stack ADT and Queue ADT in Linked list
4. Implement the Binary Search Tree Algorithm
5. Implement Graph traversals
6. Implement Sorting Algorithms

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop various applications using arrays and linked list	Apply
CO2: Examine the performance of tree operations and compare their time complexities.	Analyze
CO3: Correlate different graph algorithms and different sorting algorithms to determine the most appropriate one for a given context.	Analyze
CO4: Design and integrate multiple data structures and algorithms to create a consistent and innovative solution for a problem.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education Asia, New Delhi, 2015.

Reference Book(s):

R1. Sahni Horowitz , “Fundamentals of Data Structures in C”, 2nd Edition Tata McGraw-Hill, New Delhi, 2008.

R2. Seymour Lipschutz, “Data Structures with C”, McGraw Hill, 2014.

R3. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, “Introduction to Algorithms” 3rd Edition, The MIT Press Cambridge, 2014

Web References:

1. https://www.coursera.org/specializations/data-structures-algorithms
2. http://www.csse.monash.edu.au/~lloyd/tildeAlgDS
3. http://freevideolectures.com/Course/2279/Data-Structures-And-Algorithms

Course Code: 23EAL301		Course Title: Electronic Circuits Laboratory	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0 :3	Credits:1.5	Total Contact Hours:45	Max Marks: 100

Course Objectives:
The course is intended to impart knowledge of the design of various electronic circuits using discrete electronic components and also enables the students to design and verify the circuit using simulation software.

List of Experiments:

1. Frequency Response of CE& CS amplifiers.
2. Frequency Response of RC coupled amplifier
3. Complementary symmetry Class-B and Class AB amplifier.
4. Class C tuned amplifier.
5. Feedback amplifiers using BJT.
6. Adder, Subtractor, Integrator and Differentiator using op-amp
7. RC oscillators using Op-amp
8. LC oscillators using BJT.
9. Multivibrators using 555.
10. Applications of IC 565
11. Fixed and Variable voltage regulators
12. Simulation of above experiments using Multisim software.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Conduct experiments to obtain the frequency response of various electronic circuits for a given specifications.	Evaluate
CO2: Compare experimental results of electronic circuits using discrete components with simulation results.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	3	-	-	-	-	1	1	-	-	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	1	1	-

High-3; Medium-2;Low-1

Reference Book(s):

R1. Laboratory Manual Prepared by Faculty of Electronics and Communication Engineering, Dr. Mahalingam College of Engineering and Technology.

R2. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022

Passed in 01st Board of Studies Meeting held on 11.1.2024
Approved in 18th Academic Council Meeting held on 23.03.2024

BOS Chairman

Course Code: 23ESL301		Course Title:Professional Skills 2: Problem solving skills & Logical Thinking 2 (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Intermediate	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to enhance the students' numerical, analytical and logical reasoning ability. Also course focus to make learners prepare for various public and private sector exams and placement drives.

Module I **20 Hours**

Quantitative Ability

Time and work –Pipes and cisterns- - Time Speed Distance-Problems on Trains-Boats and Streams- Permutation and Combination-Probability, Mensuration- Heights and distance- Logarithms- Clocks and Calendars – Data Sufficiency

Module II **10 Hours**

Reasoning Ability

Number & Alpha series- Odd man out-Coding and Decoding-Syllogisms- -Problems on Cubes and Dices- Logical Venn diagram -Visual Reasoning- Element & logical series-Analogies

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Enhance their problem solving skills & Logical thinking Skills	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

T2: Dr. R. S. Aggarwal. "A Modern Approach to Logical Reasoning", Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018

Reference Book(s):

R1: R. V. Praveen. “Quantitative Aptitude and Reasoning” 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd, 2013

R2: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition, 2020

R3: Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Course Code: 23VAT301		Course Title: Universal Human Values 2: Understanding Harmony	
Course Category: VAC		Course Level: Intermediate	
L:T:P (Hours/Week) 2:1: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Induction Program

Course Objectives

The course is intended to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Strengthening of self-reflection
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Development of commitment and courage to act
5. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

Unit I Introduction to Value Education 9 Hours

Need for the Value Education; Self -exploration as the process for value education; Continuous Happiness and Prosperity: A look at basic Human Aspirations; Right understanding: Relationship and Physical Facilities; Happiness and Prosperity: current scenario; Method to fulfill the Basic human aspirations

Unit II Harmony in Human Being 9 Hours

Human being as a co-existence of self (‘I’) and the material ‘Body’; needs of Self ('I') and 'Body'; The Body as an instrument of ‘I’; Harmony in the self (‘I’); Harmony of the self (‘I’) with body; Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

Unit III Harmony in the Family and Society 9 Hours

Harmony in the Family the basic unit of human interaction; Values in human to human relationship; Trust as the foundational values of relationship; Respect as the right evaluation ;Understanding harmony in the society (society being an extension of family); Vision for the universal human order.

Unit IV Harmony in the Nature 9 Hours

Understanding the harmony in the Nature Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature; Existence as Co-existence at all levels; Holistic perception of harmony in existence.

Unit V **Harmony on Professional Ethics** **9 Hours**

Natural acceptance of human values; Definitiveness of Ethical Human Conduct; Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case study: holistic technologies, management models and production systems; Strategy for transition towards value-based life and profession

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO.1 Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO.2 Appraise physical, mental and social wellbeing of self and practice techniques to promote wellbeing.	Responding
CO.3 Value human relationships in family and society and maintain harmonious relationships.	Valuing
CO.4 Respect nature and its existence for survival and sustainable of all life forms and hence practice conservation of nature	Valuing
CO.5 Appreciate ethical behaviour as a result of value system in personal and professional situations	Receiving

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	-	-	-	-	-	-	1	2	2	-	-	2	-	-
CO2	-	-	-	-	-	1	2	2	2	1	-	2	-	-
CO3	-	-	-	-	-	2	2	2	2	1	-	2	-	-
CO4	-	-	-	-	-	2	2	2	2	-	-	2	-	-
CO5	-	-	-	-	-	1	2	2	2	-	-	2	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Book(s):

R1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

R2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

R3. The story of stuff, Annie Leonard, Free Press, New York 2010.

Web References:

1. https://aktu.ac.in/hvpe/ResourceVideo.aspx
2. http://hvpenotes.blogspot.com/
3. https://nptel.ac.in/courses/109/104/109104068/

SEMESTER IV

Course Code: 23MAT402		**Course Title: Numerical Methods and Optimization**	
Course Category: Minor		**Course Level : Intermediate**	
L:T:P(Hours/Week) 3:1:0	**Credits: 4**	**Total Contact Hours: 60**	**Max Marks: 100**

Course Objectives:

This course is designed to give an overview of numerical methods and provide knowledge and skills needed to apply these tools and techniques for decision making in organizations

Module I **22 + 8 Hours**

Solution of System of Linear Equations and Eigenvalue: Solution of system of linear equations – Gauss elimination method – Crout"s method – Iterative methods of Gauss Jacobi and Gauss Seidal method – Eigen values of matrix by Power method.

Solution of Non-Linear Equations and Curve Fitting: Solution of non-linear equations: Method of false position - Newton Raphson method – Order of convergence. Curve fitting: Method of least square – Fit a straight line – Fitting a parabola.

Interpolation, Polynomial Approximation : Interpolation with equal intervals – Newton's forward and backward difference formulae – Interpolation with unequal interval – Lagrange's interpolation

Module II **23 + 7 Hours**

Numerical Differentiation and Integration: Numerical differentiation – Numerical integration – Trapezoidal rule, Simpson's rule – Double integration using Trapezoidal rule.

Transportation & Assignment Models: Transportation problems, transportation simplex method– Assignment problems, Hungarian method- LP formulation of transportation and Assignment networks- Traveling sales man problem.

Network Models: Maximal flow problem – Shortest route problem – Minimal spanning tree problem – Project networks, CPM, PERT, Crashing of networks – LP model for crashing, project costing and control.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Determine the solution of system of linear and non-linear equations using numerical techniques.	Apply
CO2: Solve the interpolation problems and identify the basic concept of numerical differentiation and integration.	Apply
CO3: Demonstrate the application of numerical techniques in real-life situations	Apply
CO4: Calculate the optimal solution for transportation and assignment models and critical paths in projects based on minimumduration of activities.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	1	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Grewal, B.S. and Grewal, J. S., “Numerical Methods in Engineering and Science”, Eleventh Edition, Khanna Publishers, New Delhi, 2013.

T2. Hamdy A Taha, “Operations Research – An Introduction”, Prentice Hall India, 2003.

Reference Book(s):

R1. Iyengar S.R.K.” Numerical Methods”, New Age International Private Limited (2008)

R2. Philips, Ravindran and Solberg, “Operations Research”, John Wiley,2002

Web References:

1 https://archive.nptel.ac.in/courses/127/106/127106019/

2 https://onlinecourses.swayam2.ac.in/cec20_ma10/preview

Course Code: 23EAT401		Course Title: Antenna Design Technologies	
Course Category: Major		Course Level: Intermediate	
L:T:P Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

Empower students with essential antenna engineering skills, encompassing radiation mechanisms, array analysis, special antennas, microstrip antennas, smart antennas, and radio wave propagation modes, fostering hands-on design expertise

Module I **22 Hours**

Fundamental Concepts: Antenna Radiation Mechanism– Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation- Radiation from Wires and Loops: Infinitesimal dipole – finite-length dipole – linear elements near conductors – dipoles for mobile communication – small circular loop.

Aperture Antennas: Huygens' principle – radiation from rectangular and circular apertures – design considerations – Babinet's principle – Radiation from Sectoral and pyramidal horns – design concepts- prime-focus parabolic reflector and Cassegrain antennas.

Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes – extension to planar arrays.

Module II **23 Hours**

Microstrip Antennas: Basic characteristics of microstrip antennas–feeding methods-Design of rectangular patch antennas – Planar Inverted-F Antenna (PIFA), Design of microstrip patch antenna using relevant software for given applications.

Special Antennas and Design Techniques: Frequency Independent antennas-LPDA, Antenna miniaturization, Fractal antennas, Broadband Antennas-Helical Antenna- Bandwidth Improvement techniques.

Different modes of Radio Wave propagation used in current practice

Smart Antennas: Types of Smart Antennas, Beamforming Techniques, Adaptive Algorithms, Applications of Smart Antennas, Challenges and Future Trends.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify the suitable antenna for given application	Apply
CO 2: Analyze the parameters and design concepts of Antennas and smart antennas.	Analyze
CO 3: Examine the techniques and methods to improve antenna performance.	Analyze
CO4: Involve in independent/team learning and use Modern tools to design antenna for practical applications (for internal assessments only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	2	2	-	-	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. C.A.Balanis,"Antenna Theory and Design", 3 rd Ed., John Wiley & Sons. 2005.
T2. J.D.Kraus, R.J.Marhefka, “Antennas for all Applications”, Tata McGraw Hill, Third Edition, 2002.

Reference Book(s):

R1.Girish Kumar, K. P. Ray, “Broadband Microstrip Antennas” Artech House,2003
R2. Frank Gross, Smart antennas for wireless communications, McGra-Hill, 2006.
R3 R.S.Elliot,"Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.

Web References:

1. https://www.antenna-theory.com/
2. https://www.mathworks.com/help/antenna/ref/antennadesigner-app.html
3. https://www.ansys.com/en-in/blog/common-antenna-designs

Course Code: 23EAT402	Course Title: Microcontroller and Its Applications		
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the fundamentals of 8051, PIC microcontrollers & ARM processors and to demonstrate its practical applications in everyday situations.

Module I Introduction to Microprocessor and 8051 Microcontroller 22 Hours

Evolution of Microprocessor - 8085 Architecture and 8086 Architecture, Microprocessor and Microcontrollers, 8051 – Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes,/O Ports, Timers / counters, Interrupts and serial communication. Introduction to embedded C for peripheral interfacing.

Interfacing: LED 7-segment and multiplexing techniques, LCD Interfacing, Switch and matrix Keyboard Interfacing, ADC, DAC and Sensor Interfacing, RTC interfacing, Relay Interfacing, DC Motor, stepper motor and PWM.

Module II PIC Microcontroller and ARM processor 23 Hours

PIC18xx microcontroller family, Architecture, Instruction set, ROM, RAM, Timer programming, Serial port programming, Interrupt programming, ADC and DAC interfacing, CCP module and programming.

ARM processor: RISC Vs CISC Architecture, ARM Processor Architecture-ARM7TDMI, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, pipelining , ARM instruction Set and its Programming.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge of microprocessors to identify a suitable Processor and solution for a given task.	Apply
CO2: Analyze a real time application and write a suitable code using embedded C	Analyze
CO3: Design an embedded system to meet given specifications with appropriate interfacing.	Apply
CO4: Work as a team and make an oral presentation for real- time applications using appropriate tools. (for internal assessment only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	2
CO4	-	-	-	-	3	-	-	-	1	2	-	1	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, —The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2nd Edition, Pearson education, 2011

T2. Muhammad Ali Mazidi, Rolin D.McKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Prentice Hall publications, 2007

Reference Book(s):

R1. Steve Furber,“Arm System-On-Chip Architecture”, 2/E, Pearson Education,2001

R2. Krishna Kant, “Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096”, PHI, 2011.

R3. Kenneth J. Ayala “The 8051 Microcontroller”, 3rd Edition, Thompson Delmar Learning, New Delhi, 2007.

R4. Dogan Ibrahim,” Microcontroller projects in C for the 8051” Newnes, Oxford, 2000

Web References:

1. https://archive.org/details/microcontrollerp0000ibra/page/n1/mode/2up
2. https://archive.nptel.ac.in/courses/108/105/108105102/#

Course Code: 23EAT403		Course Title: Digital Communication	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to impart knowledge on digital communication such as sampling, Quantization, waveform coding, baseband transmission and digital modulation scheme.

Module I **23 Hours**

Sampling and quantization :

Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Logarithmic Companding of speech signal, Analog Pulse modulation techniques: PAM– PPM– PWM, TDM

Waveform coding :

PCM -Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles-Linear Predictive Coding

Baseband transmission :

Properties of Line codes, Power Spectral Density of Unipolar, Polar and Bipolar RZ & NRZ Manchester, ISI, Nyquist criterion for distortion less transmission, Correlative coding, M-ary schemes, Eye pattern

Module II **22 Hours**

Digital modulation scheme:

Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Principle of DPSK, Pseudo noise sequences, Discrete sequence spread spectrum with coherent BPSK, Frequency hop spread spectrum modulation

Error control coding :

Channel coding theorem, Linear block codes, Hamming codes, Cyclic codes, Convolutional codes, Viterbi decoding, Trellis coding

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the different pulse modulation systems and waveform coding techniques.	Analyze
CO2: Apply the characteristics of the line codes used for digital data transmission	Apply
CO3: Compare the performance of digital modulation techniques and spread spectrum techniques	Analyze
CO 4: Analyze and implement various error control codes to detect and correct errors in digital communication	Analyze

Course Articulation Matrix

CO Vs PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book:

T1. S. Haykin, “Digital Communications”, John Wiley, 20

T2. B.P.Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems” 4thEdition, Oxford University Press 2011

Reference Book(s):

R1. Bernard Sklar, “Digital Communications: Fundamentals and Applications”, 2ndEdition, Prentice Hall,2009

R2. J.G Proakis, “Digital Communication”, 4th Edition, Tata McGraw Hill Company, 2001

R3. H P Hsu, Schaum Outline Series - “Analog and Digital Communications”, TMH 2006

R4. Leon W “Couch , “Digital and Analog Communication Systems” , 6th Edition, Prentice Hall , 2001

Web References:

1. https://www.tutorialspoint.com/principles_of_communication/principles_of_communication_digital_modulation_techniques.htm

Course Code: 23EAT404		Course Title: CMOS VLSI Design	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:
The course is intended to impart knowledge on fundamentals of CMOS VLSI design, design of VLSI subsystems and concepts related to CMOS memories and clocking styles.

Module I **22 Hours**

Introduction to MOS Transistor: Moore's law, VLSI Design Process: Design specification – design entry – function simulation – planning, Placement and routing – timing simulation, flipflop and latch related timing issues, fabricating into chip – CMOS processing technologies – nWell – pWell – Twin tub – Silicon on insulator, BiCMOS – FINFET Technology.

MOS Transistor and Inverters: Basic MOS Transistors and Operation: NMOS enhancement transistor and PMOS enhancement transistor – Threshold Voltage – Derivation of drain current – Channel length modulation – Body Effect – Trans conductance – MOSFETs as switches – CMOS Inverter – latchup in CMOS Circuit – power dissipation in CMOS circuits.

Module II **23 Hours**

Logic Design with CMOS: Logic gates in static CMOS – Transistor sizing – Stick diagram, Layout diagrams and design rules – rationed circuits: pseudo NMOS – cascade voltage switch logic – Dynamic CMOS logic: domino logic, dual rail domino logic – Transmission gate – pass transistor circuits – CMOS Design and functional Verification of Basic logic gates.

VLSI Subsystem Design: CMOS Multiplexer, Equality Detector – Shift and Rotation Operation – Parity generators – Ripple carry Adder – Carry look Ahead Adder – Carry Skip Adder – Carry Select – Carry Save Array – Braun / Baugh Wooley – Modified Booth Encoded Multiplier, Introduction to Verilog.

CMOS Memories and Clocking: Conventional CMOS Latches, CMOS D Flip-flop, SDFF – TSPC Flip-flop – CMOS static RAM Dual Port SRAM – SRAM arrays – DRAM and Floating Gate MOSFET – Flash Memory CMOS Clocking Styles Pipelined Systems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze different fabrication steps involved in VLSI design process and examine various fabrication technologies.	Analyze
CO2: Model drain current equations and solve latchup in CMOS circuits.	Apply
CO3: Design different subsystems and develop HDL for adders and multipliers**.**	Apply
CO4: Examine CMOS memories and different clocking styles.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3		-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO4	-	2	-	-	-	-	-	-	-	-	-	-	-	2

High-3; Medium-2;Low-1

Text Book(s):

T1. Weste and Harris, CMOS VLSI Design: A circuit and System perspective, Third edition, Pearson Education, 2005.

T2. Samirpalnitkar, Verilog HDL: A Guide to digital design and Synthesis, Second edition, Pearson Education, 2003.

Reference Book(s):

R1.Umeyura John P *,* Introduction to VLSI Circuits and Systems*,* John Wiley and Sons, 2004.

R2.Douglass A Pucknell, Basic VLSI Design, Prentice Hall of India Publication, 2002.

Web References:

1.https://nptel.ac.in/courses/117101105/

2.https://www.nptel.ac.in/117101006/

3.https://www.siliconmentor.com/analog-vlsi-design/

Course Code: 23EAL401		Course Title: Analog and Digital Communication Laboratory	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0 : 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart practical knowledge on various modulation and demodulation techniques using hardware kits and MATLAB software.

List of Experiments

1. Carry out the Amplitude modulation/Demodulation using hardware.
2. Carry out the Frequency modulation/Demodulation using hardware.
3. Verify the sampling theorem in the hardware.
4. Carry out the PAM, PWM and PPM using hardware.
5. Perform the operation of PCM encoding/ decoding using hardware.
6. Perform the operation of ASK and FSK using hardware.
7. Carry out the modulation and demodulation of BPSK using hardware.
8. Carry out the modulation and demodulation of QPSK using hardware.
9. Carry out the CRC Error control coding using hardware.
10. Carry out the Convolutional coding using hardware.
11. Simulate AM, FM using MATLAB software.
12. Simulate ASK, FSK, PSK using MATLAB software.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the various analog modulation systems with various modulation index	**Analyze**
CO2: Evaluate the different pulse modulation techniques based on its characteristics	**Evaluate**
CO3: Verify various error control coding schemes by using a suitable encoding and decoding methods	**Analyze**
CO4: Evaluate the various digital modulation schemes using their appropriate characteristics using Matlab	**Evaluate**

Course Articulation Matrix

CO Vs PO	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
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	3	2	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	1	2	3	-	-	1	-	1	-	-	3	-

High-3; Medium-2; Low-1

Reference Books :

R1. John G.Prokias, Masoud Salehi and Gerhard Bauch, "Contemporary Communication Systems using MATLAB", 3rd Edition, Cengage learning, 2012.
R2. “Communication Systems Laboratory manual”, prepared by the ECE Department.
R3. Kwonhue Choi, Huaping Liu, “Problem-Based Learning in Communication Systems Using MATLAB and Simulink”, Wiley IEEE Press, 2016.

Course Code: 23EAL402		Course Title: Microcontroller Laboratory	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on basic concepts of 8051,PIC microcontroller & ARM processor with its peripheral devices interfacing and to develop the assembly language programming, C programming skills of 8051 microcontroller.

List of Experiments:

1. Arithmetic Operations using 8051 assembly language programming.
2. Sorting/ Searching of Data using 8051 assembly language programming

C programming

3. Stepper Motor interfacing with 8051
4. ADC /DAC interfacing with 8051
5. Interfacing LED with Time Delay using Inbuilt Timer in 8051
6. Asynchronous serial communication using PIC Microcontroller
7. Dc motor control using PIC microcontroller
8. Seven segment display using PIC Microcontroller
9. LCD interfacing with PIC Microcontroller
10. LED, Switch and Buzzer interfacing with LPC2148 ARM processor
11. Generation of PWM Signal with LPC2148 ARM processor
12. Relay interfacing with LPC2148

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: :Develop assembly language program using 8051 instructions given operations	Apply
CO 2: Engage as an individual and Conduct experiment to Interface the given processor with an external device and verify its functionality for real time problems.	Evaluate
CO 3: Use an appropriate tool to simulate the program for on-chip peripherals of the given processor for the given specifications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	3	-	-	-	-	3	2	-	-	-	-
CO3	-	-	-	-	3	-	-	-	-	-	-	3	2	2

High-3; Medium-2; Low-1

References: “Laboratory manual”, prepared by the department

Passed in 01st Board of Studies Meeting held on 11.1.2024
Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

SEMESTER V

Course Code: 23EAI501		Course Title: Signal processing for Communication	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 2	Credits: 4	Total Contact Hours: 75	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on advancements in signal processing algorithms and communication techniques to enable high-speed, reliable, and energy-efficient data transmission while optimizing the utilization of radio frequency spectrum and transmitted signal power.

Module I **22 Hours**

Stochastic Signal Processing: Introduction and Basics: Signals and Systems - Classification of Signals - System Properties. Random Processes: Stationary random process – Ergodicity - Power spectral density and autocorrelation function of random processes. Noise power spectral density analysis - Noise bandwidth and noise figure of systems. **Interpolation and Sampling:** Inner product and convolution – convolution theorem – Band limited signals. Interpolation – local interpolation – polynomial interpolation – Sinc interpolation. Sampling Theorem – Aliasing in communication - Discrete time processing of analog signals.

Module II **23 Hours**

Fourier Analysis: Fourier series and properties: Aperiodic signal analysis - Fourier Transform - properties and sinusoidal steady state analysis of systems-Discrete time Fourier transform - Fourier transform for periodic signals - Time and frequency characterization of signals and systems – magnitude phase representation of Fourier transforms. **Multirate Signal Processing:** Quantization – A/D conversion - D/A conversion – Downsampling – Properties of the Downsampling Operator - Frequency-Domain Representation - Downsampling of a Highpass Signal – Filtering - Upsampling – interpolation - Rational Sampling Rate Changes – Oversampling - Oversampled A/D Conversion - Oversampled D/A Conversion. **Design of a Digital Communication System:** Filter Design: FIR filter design using windowing – Digital IIR filter design using BLT. The Communication Channel - The AM Radio Channel - The Telephone Channel - Modem Design:The Transmitter - Modem Design: the Receiver - Hilbert Demodulation

List of Experiments **30 Hours**

1. Generation of Standard continuous and discrete time sequences and carrying out of arithmetic operations and plot the results.

2. Compute the Convolution and Correlation between sequences.

3. Verification of sampling theorem.

4. Design of FIR filters for the given specification and plot the frequency response of the designed filter

5. Design of IIR filters for the given specification and plot the frequency response of the designed filter

6. To plot the wave forms for QPSK signal subjected to Rayleigh AWGN

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1 : Apply the knowledge to design and obtain the specified parameter/representation for the given continuous time signal/system using time domain, frequency domain and transform domain representation	Apply
CO2 : Analyze and classify the given signal/system using time domain, frequency domain and transform domain representation	Analyze
CO3 : Apply the knowledge of signal processing to obtain the time and frequency domain representation communication systems.	Apply
CO4 : Conduct experiments to demonstrate concepts related to analog and digital communication using suitable electronic components/Engineering Tool (Matlab).	Create
CO5 : Ability to develop and deliver an oral presentation of the application concepts of the course for transmission of audio /image/ video/ data signal for benefit of society (for internal assessment only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	3	-	3	-	-	-	-	-	-	-	2	-
CO5	-	-	-	-	-	-	-	-	-	2	-	-	-	-

High-3; Medium-2;Low-1

Passed in 3rd Board of Studies Meeting held on 13.12.2024
Approved in 19th Academic Council Meeting held on 03.01.2025 BOS Chairman

Text Book(s):

T1. Prandoni, Paolo, and Martin Vetterli. Signal processing for communications. EPFL press, 2008

T2. Oppenheim, Alan V - Discrete-time signal processing, Pearson Education India.

Reference Book(s):

R1. Multirate Systems and Filter Banks, P.P. Vaidyanathan, Prentice-Hall, 1993

R2. Statistical digital signal processing and modeling, Monson H.Hayes, Jhon Wiley & Sons

R3. Proakis J. G. and Salehi M, "Communication Systems Engineering", Pearson Education, 2002.

Web References:

1. https://onlinecourses.nptel.ac.in/noc24_ee28
2. https://onlinecourses.nptel.ac.in/noc24_ee36
3. https://onlinecourses.nptel.ac.in/noc24_ee76

Course Code: 23EAT501		Course Title: Microwave and optical communication	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3 : 0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on microwave and optical communication principles, focusing on transmission lines, devices, fiber fabrication, signal degradation, optical sources, detectors and switches.

Module I **22 Hours**

Microwaves - Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC. High frequency parameter – High frequency transmission line analysis.

Passive and Active Microwave Devices - Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers.

Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.

Module II **23 Hours**

Fundamentals of Optical Communication: propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model. Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Optical sources - LEDs and Lasers, Photo-detectors - pin-detectors, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.

Optical switches - coupled mode analysis of directional couplers, electro-optic switches

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify the suitable microwave device for the given application based on its characteristics	Apply
CO 2: Use mathematical models to analyze the high frequency characteristics of transmission line	Analyze
CO 3: Analyze the different models of light and its propagation in different types of optical fiber	Analyze

CO 4: Simulate and conduct experiments in teams involving the design of Microwave components and high-capacity advanced optical communication systems	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	
CO2		3											3	
CO3		3											3	
CO4			2		3				3				3	

High-3; Medium-2;Low-1

Text Book(s):

T1. Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson Education, 2003

T2. J. Keiser, Fibre Optic communication, McGraw-Hill, 4th Edition 2010

Reference Book(s):

R1. K.C. Gupta and I.J. Bahl, Microwave Circuits, Artech house, 3rd Edition, 2013

R2. David M. Pozar, Microwave Engineering, 4th Edition, Wiley India, 2013

R3. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 5th Edition, 2023

Web References:

1. https://www.microwaves101.com/
2. https://archive.nptel.ac.in/courses/108/101/108101112/
3. https://archive.nptel.ac.in/courses/108/106/108106167/

Course Code: 23EAT502		Course Title: Wireless Communication	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on key wireless cellular concepts, designing a Mobile Radio Propagation using various modulation techniques and to understand wireless networks.

Module I **22 Hours**

Cellular Concept and Mobile Radio Propagation: Multiple Access techniques - FDMA, TDMA, CDMA – Cellular Concept – frequency reuse – channel assignment strategies – Handoff strategies: prioritizing handoff's, practical considerations – interference and system capacity – Trunking and Grade of service – methods to improve coverage and capacity. Large scale path loss: free space propagation model – three basic propagation mechanisms: reflection, Diffraction, scattering. Small Scale Fading and factors influencing small scale fading, Doppler Shift, Coherence Bandwidth, Doppler spread and Coherence Time, types of small scale fading: fading effects due to multipath time delay spread, fading effects due to Doppler spread.

Module II **23 Hours**

Digital Modulation Techniques and Wireless Networking: Linear Modulation Techniques: Quadrature phase shift keying (QPSK) transmission and detection techniques, Minimum shift keying(MSK), Gaussian Minimum Shift Keying(GMSK), M-ary phase shift keying(MPSK). Error performance in fading channels, OFDM: Principle - cyclic prefix – Channel estimation – PAPR. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver. Development of Wireless Networks: First, Second and Third Generation Wireless Networks, Fixed Network Transmission Hierarchy, Traffic Routing in Wireless Networks: Circuit Switching, Packet Switching. Personal Communication Services/ Networks(PCS/PCNs): Packet Vs Circuit Switching For PCN, Cellular Packet Switched Architecture- Packet Reservation Multiple Access(PRMA) - Universal Mobile Telecommunication Systems(UMTS).

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the various terms with respect to Wireless Communication	Understand
CO2: Analyze Mobile Radio Propagation using Various Digital Modulation Techniques.	Apply
CO3: Identify and Analyze wireless communication networks for personal communication services / Networks.	Analyze
CO4: Perform simulation using MATLAB for Wireless standards and evaluate the performance measurements for 4G and 5G as a team (for Internal Assessment Only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	3	2	-	-	-	-	-	-	-	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Rappaport,T.S.,-Wireless communications", Pearson Education, Second Edition, 2010.

T2. Andrea Goldsmith, "Wireless Communication", Cambridge University Press, 2011.

Reference Book(s):

R1. Van Nee, R. and Ramji Prasad, —OFDM for wireless multimedia communications, Artech House, 2000

R2. David Tse and Pramod Viswanath, —Fundamentals of Wireless Communication, Cambridge University Press, 2005.

R3. Andreas.F. Molisch, —Wireless Communications", John Wiley – India, 2006.

R4. Wireless Communication and Networks –William Stallings ,Pearson Education, Second Edition 2002

Web References:

1. https://www.mathworks.com/solutions/wireless-communications/standards.html

2. https://www.mathworks.com/help/5g/test-and-measurement.html

Course Code: 23EAL501		Course Title: Microwave and Optical Communication Laboratory	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 0:0 :3	Credits: 1.5	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to experiment the characteristics of Microwave components, to perform microwave measurements and to verify the characteristics of optical fiber and sources.

List of Experiments:

1. Measurement of Power Distribution in directional coupler
2. Measurement of Power Distribution Magic Tee
3. Characteristics of Gunn Diode Oscillator
4. Characteristics of Reflex Klystron Oscillator
5. Radiation pattern measurement of Horn Antenna
6. Design of low pass and high pass filters using ADS
7. Determination of VSWR and impedance matching using microstrip lines
8. Measurement of Antenna parameters and RF passive component characteristics using Vector Network Analyzer
9. Discover the source of EMI emissions in with near-field probes
10. Measurement of Numerical Aperture and bending losses in Optical Fiber.
11. VI characteristics of LED and LASER Diode.
12. Optical Time Domain Reflect meter

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Conduct experiments to verify the characteristics of microwave devices and optical systems	Analyze
CO 2: Simulate and conduct experiments in teams involving the design of Microwave circuits and measurements	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	1	1	-	-	-	-
CO2	-	-	3	-	3	-	-	-	3	-	-	-	3	-

Reference Book(s):

Lab manual prepared by the department

Course Code: 23ESL501		Course Title: Professional Skills 4: Communication Skills and Interview Essentials (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Higher	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to equip students with the necessary skills to effectively communicate in various professional settings and excel in the interview process

Module I **15 Hours**

Resume Building & Portfolio Management

Importance of a Strong Resume - Resume Content Development & Core Components – Formatting and Design - Tailoring and Customization – Proofreading - Portfolio Content, design and Structure : Components & Efficient portfolios – Preparing and Maintaining documents for interview – maintaining repositories - Enhancing Personal Brand - Digital Tools and Platforms

Interview - Dress code, Body Language and Grooming

Dress Code Essentials - Body Language – Facial expression, eye contact, gesture, posture, touch behavior & space- Personal Grooming

Effective Communication

Communication in Diverse Contexts - Presentations – Individual and group presentations - Public Speaking - Visual Aids and Presentation Tools

Module II **15 Hours**

Group Discussion

Introduction & types of Group Discussion – Prerequisites of GD – Techniques and tips of GD - Role of GDs in various professional contexts – GD Etiquettes – Strategies to enhance GD – Mock GD.

Interview Skills

Purpose of an interview - Types of Interviews –Interview Techniques – Interview Etiquette - Planning and Preparation - Mock Interviews with Feedback - Post-Interview Etiquette and Follow-Up

Activities:

Building Portfolio: Resume Building, Updating LinkedIn, Maintaining Repositories.

Effective Presentation: Oral Presentation: Impromptu speech, Mini Presentation, Picture Perception (Both Speaking and Writing)

Visual presentation: Power Point Presentation, Vlog

Group Discussion: General, Technical

Mock Interview: General, Technical

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Communicate effectively and exhibit required competency in various professional environments and demonstrate proficiency in interview process.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1. Ashraf Rizvi, "Effective Technical Communication" 2nd Edition, McGraw-Hill India, 2018

T2. Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

Reference Book(s):

R1. Cheryl Hamilton, “Communicating for Results: A Guide for Business and the Professions”, 11th edition (1 January 2017), Wadsworth Publishing Co Inc.

R2. Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3. Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

Web References:

1 https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/

2 https://www.simplilearn.com/group-discussion-tips-article

Course Code: 23EAP501		Course Title: Reverse Engineering Project	
Course Category: Project		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:6	Credits: 3	Total Contact Hours: 90	Max Marks:100

Course Objective:

This course aims to equip students with practical skills in analyzing, disassembling, modeling, and validating electronic systems through reverse engineering, fostering innovation and design thinking in electronics , and advanced communication technologies.

Module 1 **45 Hours**

Introduction to Reverse Engineering in Electronics-Identifying Target Electronic Systems - Technical Data Collection: Datasheets, Application Notes, Circuit Manuals-Safe Disassembly of Electronic Hardware-Identification of Components and Subsystems-Functional Analysis of Circuits: Power Section, Control Logic, Interfaces

Module 2 **45 Hours**

Reconstructing Circuit Schematics from Disassembled Boards-Flowchart and Logic Analysis-Circuit Simulation-Validating Functionality through Simulation and Test Cases-Debugging Techniques and Troubleshooting.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge of electronic components and subsystems to analyze disassembled hardware and interpret its functional blocks.	Apply
CO2: Analyze circuit behavior and signal/data flow in communication and control sections of electronic systems.	Analyze
CO3: Reconstruct circuit schematics and simulate their operation to validate the original system functionality.	Evaluate
CO4: Create a comprehensive technical report including schematic diagrams, functional analysis, simulation results, and safety observations.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	1
CO3	-	-	-	3	3	-	-	-	-	-	-	-	3	1
CO4	-	1	-	-	-	1	1	1	-	1	-	2	1	1

High-3; Medium-2; Low-1

Web References

1. J. Platt, "An industrial approach to reverse engineering," in *Proc. IEEE Int. Conf. on Engineering Education*, Vancouver, BC, Canada, July 2005, pp. 6–10.
2. K. T. Ulrich and S. D. Eppinger, *Product Design and Development*, 6th ed., New York, NY, USA: McGraw-Hill, 2016.

SEMESTER VI

Course Code: 23EAT601		Course Title: Software Defined Radio	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on software defined radio (SDR) by introducing the architecture, components and its working principles to highlight the importance of SDR in modern wireless communication.

Module I **22 Hours**

Need for software defined radio - History of SDR, definition, characteristics and benefits of SDR, design principles of SDR- requirements for Software Defined Radio - Legacy Systems, The Benefits of Multi-standard Terminals- Economies of Scale, Global Roaming, Service Upgrading, Adaptive Modulation and Coding, Operational Requirements - Key Requirements, Reconfiguration Mechanisms, Handset Model, New Base Station and Network - Architectures, Separation of Digital and RF, Tower-Top Mounting, BTS (Base-station transceiver system) Hoteling, Smart Antenna Systems- Smart Antenna System Architectures, Power Consumption Issues, Calibration Issues.

Module II **23 Hours**

Software Defined Radio Architectures, Ideal Software Defined Radio Architecture, Required Hardware Specifications, Digital Aspects of a Software Defined Radio - Digital Hardware, Alternative Digital Processing Options for BTS Applications, Alternative Digital Processing Options for Handset Applications, Current Technology Limitations - A/D Signal-to-Noise Ratio and Power Consumption, Derivation of Minimum Power Consumption, Power Consumption Examples, ADC Performance Trends, SDR as a platform for Cognitive Radio- spectrum sensing and management - applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the basic principles of SDR and describe its architecture and components	Understand
CO 2: Apply adaptive modulation techniques to optimize the network performance in BTS	Apply
CO 3: Analyze the performance of smart antennas and alternate digital processing in SDR systems	Analyze
CO 4: Analyze the impact of cognitive functionalities in SDR systems for improving spectrum efficiency	Analyze
CO 5: Investigate and present orally as team on the applications of SDR on real world scenarios (for internal assessment only)	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	2	-	-	-	-	3	-	-	-	-	3

High-3; Medium-2;Low-1

Text Books:

T1. “RF and Baseband Techniques for Software Defined Radio” Peter B. Kenington, ARTECH HOUSE, INC © 2005.

T2. Bruce A. Fette, “Cognitive Radio Technology”, Elsevier, 2009.

Reference Books:

R1. Software Radio: A Modern Approach to Radio Engineering by Jeffrey H. Reed Pearson Education, 2002.

R2. Markus Dillinger, KambizMadani, Nancy Alonistiotic,” Software Defined Radio”, John Wiley, 2003.

R3. Joseph Mitola III, “Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering”, John Wiley and Sons Ltd.2000.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ee78/preview
2. https://www.everythingrf.com/community/what-is-a-software-defined-radio
3. https://in.mathworks.com/discovery/sdr.html

Course Code: 23EAT602		Course Title: MIMO and OFDM Techniques	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives: The course aims to provide an in-depth understanding of MIMO (Multiple Input Multiple Output) and OFDM (Orthogonal Frequency Division Multiplexing) technologies, essential for modern wireless communication systems. Additionally, the course emphasizes simulation techniques and practical applications in 4G/5G systems.

Module I **22 Hours**

Basics of wireless communication and channel characteristics - Introduction to MIMO systems: concepts, types, and advantages - MIMO channel capacity, spatial diversity, and spatial multiplexing - Fundamental principles of OFDM: subcarrier orthogonality, FFT/IFFT, and spectral efficiency - MIMO-OFDM system models and their advantages in wireless communication - SISO vs. MIMO in OFDM systems.

Module II **23 Hours**

Channel estimation and equalization techniques for MIMO-OFDM - Beamforming and diversity techniques in MIMO - Space-Time Block Codes (STBC), Space-Frequency Codes (SFC), and Spatial Multiplexing - MIMO-OFDM system performance in multipath fading channels - Case studies in LTE and 5G communication standards using MIMO-OFDM - Simulation tools: MATLAB, Simulink, and relevant 5G NR standards in wireless system simulators.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the fundamental principles of MIMO and OFDM in wireless systems.	Apply
CO 2 : Analyze channel capacity and spectral efficiency in MIMO-OFDM systems.	Apply
CO 3: Implement and evaluate MIMO-OFDM algorithms for channel estimation and equalization .	Analyze

CO 4 : Design and simulate MIMO and OFDM-based wireless communication systems using modern tools as teams.	Create
CO 5: Assess the performance of MIMO-OFDM systems in real-world applications, such as LTE and 5G.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	2	-	-	-	-	2
CO5	-	-	-	-	2	-	-	-	-	-	-	-	-	2

High-3; Medium-2;Low-1

Text Book(s):

T1. Tse, D., & Viswanath, P. (2005). Fundamentals of Wireless Communication. Cambridge University Press.

T2. Goldsmith, A. (2005). Wireless Communications. Cambridge University Press.

Reference Book(s):

R1. Rappaport, T. S. (2014). Wireless Communications: Principles and Practice (2nd ed.). Pearson.

R2. Molisch, A. F. (2011). Wireless Communications (2nd ed.). Wiley.ollin, R. E. (2000).

Web References

1. www.nptel.ac.in/courses/108/106/108106170/
2. www.keysight.com/us/en/solutions/5g.html
3. www.mathworks.com/solutions/wireless-communications.html
4. www.comsoc.org/publications/standards-5g

Course Code: 23EAL601		Course Title: Software Defined Radio Laboratory	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 0:0 :3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the analog and digital modulation and demodulation techniques. Students will gain hands-on experience in implementing various modulation and demodulation schemes using software-defined radio platforms. They can implement communication systems, analyze their performance, and troubleshoot potential issues.

List of Experiments:

1. Implementation of AM Modulation and Demodulation using SDR platform.
2. Implementation of FM Modulation and Demodulation using SDR platform.
3. Perform ASK Generation and Regeneration using SDR platform.
4. Perform FSK Generation and Regeneration using SDR platform.
5. Perform BPSK Generation and Regeneration using SDR platform.
6. Perform QPSK modulation and demodulation using SDR platform.
7. Implementaion of pulse shaped filters using SDR platform.
8. Implementaion of matched filters using SDR platform.
9. BER Measurement of BPSK using SDR platform.
10. BER Measurement of QPSK using SDR platform.
11. Transmission of Audio via FM and Reception of the Audio via Mobile using SDR platform.
12. Implementation of Spread Spectrum of FM Signals using SDR platform.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze various analog and digital modulation and demodulation techniques	Analyze
CO 2: Analyze pulse shaping filters to improve the spectral efficiency and bit error rate of digital communication systems.	Analyze
CO 3 : Engage as an individual or team and measure the bit error rate (BER) performance of different modulation schemes and analyze the impact of noise and interference.	Analyze
CO 4 : Effectively use SDR platforms to implement and test various communication systems.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	2	-	-	2	-	2
CO4	-	3	-	-	-	-	-	-	-	-	-	2	-	-

High-3; Medium-2;Low-1

Reference Book(s):

R1.Laboratory Manual Prepared by the Faculty of Electronics and Communication Engineering, Dr. Mahalingam College of Engineering and Technology.

Course Code: 23EAL602		Course Title: MIMO and OFDM Laboratory	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) :0 0:3	Credits:1.5	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on simulation of various performance parameters and techniques for MIMO-OFDM systems.

List of Experiments:

1. Study of channel model and plot pdf of Rayleigh channel and Rician channel
2. Generation of correlated MIMO Fading Channel
3. Implement and Compare the capacity of SISO and MISO channels.
4. Simulation of BER of a MIMO system using STBC
5. Determination of Channel capacity for MIMO System with Nt transmit and Nr Receive antennas
6. Simulate OFDM Transmitter and receiver, evaluate the BER performance.
7. Implementation of Successive interference cancellation for a 2 X 2 MIMO OFDM system: VBLAST MIMO OFDM
8. Implementation of least square error channel estimation for a MIMO OFDM system.
9. Study of different Equalization and Diversity schemes in a Space-Time Block Coded (STBC) MIMO system
10. Perform Maximum Likelihood equalization for MIMO Systems using Space time block code.
11. Study of Performance Analysis of MIMO-OFDM with MMSE Equalizer.
12. Performance Analysis of MIMO-OFDM with Pilot-Based Channel Estimation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze and Simulate performance parameters of MIMO-OFDM system.	Analyze
CO 2: Investigate the bit error rate performance of various techniques in MIMO-OFDM System.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	3	-	-	-	1	-	-	-	-	2
CO2	-	-	-	3	3	-	-	-	1	-	-	-	-	2

High-3; Medium-2;Low-1

Reference Book(s):

R1. MIMO-OFDM Wireless Communications with MATLAB , by Yong Soo Cho, Jaekwon Kim, Won Young Yang, Chung-Gu Kang , Wiley, 2018.

R2. Laboratory Manual Prepared by Faculty of Electronics and Communication Engineering, Dr. Mahalingam College of Engineering and Technology.

Course Code:23ESL601		Course Title: Professional Skills 5: Ace and Elevate : Aptitude and Soft Skills (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level:Higher	
L:T:P (Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours: 30	Max Marks: 100

Course Objectives:

To enhance students' problem-solving skills in the aptitude segment while also equipping them with effective communication skills for professional settings and success in the interview process.

Module I Verbal Ability & Effective Communication **15 Hours**

Verbal Ability

Parts of Speech – Tenses – Subject Verb Agreement – Synonyms – Antonyms – Idioms and Phrases - One Word Substitution – Reading Comprehension – Cloze test – Error Spotting.

Verbal Enhancement

Self-Introduction – Just A Minute- Picture Perception - Writing Skills: Sentence Types (Simple, Compound, Complex), Email drafting.

Campus to Corporate

Professional Grooming –Group Discussion – Impromptu – Interview.

Module II Quantitative & Reasoning Ability **15 Hours**

Quantitative Ability

Simplification & Approximation, Number System, Percentage, Averages, Ratios and Proportion, Ages, Profit & Loss, Interest Calculation, Time and work, Time, speed and distance, Clocks and Calendar, Mixtures and alligation, Permutations and Combinations, Probability, Mensuration, Data Interpretation, Data Sufficiency

Reasoning Ability

Seating Arrangement, Blood relations, Directions Problems, Syllogisms, Number & Alpha Series, Coding and Decoding, Non Verbal Reasoning, Analogies, Cubes and Dices.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Exhibit strong problem-solving skills in the aptitude segment while enhancing their communication abilities for professional settings, enabling them to excel in interviews and placement processes.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Technical Communication, 3E: Principles and Practice book. Authors. Meenakshi Raman, Sangeeta Sharma, 2006

T2: Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

T3: Dr. R. S. Aggarwal. “Quantitative Aptitude for Competitive Examinations” Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

T4: Dr. R. S. Aggarwal. “A Modern Approach to Verbal and Non-Verbal”, Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

Reference Book(s):

R1: Cheryl Hamilton, “Communicating for Results: A Guide for Business and the Professions”,

R2: Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3: Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

R4: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition, 2020

R5: Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1. https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/
2. https://www.simplilearn.com/group-discussion-tips-article
3. https://talentbattle.in
4. https://www.geeksforgeeks.org/aptitude-questions-and-answers/

SEMESTER VII

Course Code: 23EAT701		Course Title: 5G Communication Technologies	
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

This course is intended to impart knowledge on fundamental principles of 5G Communication, Architecture and its key components, Radio access techniques and Network slicing in 5G scenarios

Module I **23 Hours**

Introduction: Introduction of 3G and 4G (LTE, LTEA, LTEA Pro), 5G overview, requirements, Spectrum access modes and Sharing for 5G.

Channel Modeling : Channel modeling requirements, propagation scenarios and challenges in the 5G modeling

System Architecture: 5G core network architecture, Radio Accesses Network (RAN) architectures, Interference management, mobility management and handover in 5G.

Physical Layer and Deployment: 5G Physical channels, signals and frame structure; Small cell deployments: different types, Deployment scenarios, performance and analysis, 3GPP RAN standards for small cell

Module II **22 Hours**

Device-to-device (D2D) and machine-to-machine (M2M) type communications: Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi operator D2D communications

Millimeter-wave Communications: Millimeter bands, radio-wave propagation, Physical layer design, beam-forming, interference and mobility management; Massive MIMO (Sub 6 GHz) - mm wave MIMO (above 6GHz), Smart Antennas for 5G

5G Network Slicing: Introduction of Network Slicing, E2E Slicing, SDN and NFV Slicing

Vehicular Communication: From V2V to AV2X, key standards, VC architectures basics

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the principles of 5G wireless communication, including evolution from 3G/4G, spectrum sharing, and core/RAN architecture, to analyze system-level design and mobility management.	Apply
CO 2: Analyze the challenges of channel modeling, propagation, and physical layer design including frame structures, small cell deployments, and 3GPP standards.	Analyze
CO 3: Apply 5G techniques to real-world use cases like device-to-device (D2D), machine-to-machine (M2M), and vehicular communication (V2X) considering multi-operator and multi-hop scenarios.	Apply
CO 4: Analyze advanced 5G technologies such as millimeter-wave communication, massive MIMO, smart antennas, and implement network slicing using SDN and NFV concepts.	Analyze
CO 5: Apply basic 5G communication concepts by working in teams to simulate a simple D2D or V2X scenario using open-source tools, while considering safety, ethical use, and communicating the findings clearly. (For internal assessment only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	3
CO5	2	-	-	-	3	2	-	2	2	1	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Martin Sauter, From GSM to LTE—Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Wiley-Blackwell

T2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, Fundamentals of 5G Mobile Networks , Cambridge University Press

T3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, New Directions in Wireless Communication Systems from Mobile to 5G, CRC Press

T4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock, Millimeter Wave Wireless Communications, Prentice Hall Communications

Reference Book(s):

R1. . Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons

R2. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015

R3. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019.

Web References:

1. https://nptel.ac.in/courses/108105134
2. https://nptel.ac.in/courses/117104484

Course Code: 23EAT702		Course Title: RF Circuit Design	
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart students with the fundamental knowledge and practical skills necessary to design, analyze, and implement high-performance RF circuits and systems.

Module I **22 Hours**

Radio frequency concepts: Frequency spectrum and applications – Behavior of passive components at radio frequencies – Design parameters. RF Passive components: Transmission lines and equivalent circuits – Design of transmission lines and transmission lines based devices – Smith chart representation

RF Network theory: Interconnection of networks – Scattering parameters and properties – RF measurements and principles. Active RF components and modeling: Diode – Transistor – measurements of parameters – scattering parameter characterization.

23 Hours

Module II

RF System Design: Impedance matching concepts – Microstrip matching – Transistor biasing networks – Amplifier design concepts and power relations – small signal amplifier design-design of different , types of amplifiers-narrow band, high gain, maximum gain, low noise broad band amplifier design.

RF/Microwave oscillator design-Oscillator versus amplifier design , oscillations conditions, design of transistor oscillators, fixed frequency,Frequency tunable oscillators.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: To understand the behavior of passive components at RF frequencies and understand the principles of RF propagation and transmission.	Understand
CO 2: To apply network analysis techniques to design and analyze basic RF circuits, including transmission lines and impedance matching networks.	Apply
CO 3: To analyze the performance of RF amplifiers and oscillators, considering factors like gain, noise, and frequency stability.	Analyze
CO 4: Implement basic RF circuits using any EM tool and give a oral presentation as team (For internal assessment only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	3	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-	3	-
CO4	1	3	-	-	3	-	-	-	-	3	-	-	3	-

High-3; Medium-2;Low-1

Text Books:

T1. R. Ludwig and P. Bretchko, “RF Circuit Design-Theory and Applications”, Pearson Education, First Edition, 2006.

T2. Matthew M Radmanesh, “Radio Frequency and Microwave electronics”, Pearson Education Asia, 2001.

Reference Books:

R1. D.M.Pozar, “Microwave Engineering”, Wiley India Limited, Third Edition, 2007

R2.. Less Besser and Rowan Gilmore, “Practical RF Circuit Design for Modem Wireless Systems”, Vol.2.

R3. Joseph Carr., “Secrets of RF Design”, 3rd Edition, Tab Electronics.

Web References:

1. https://onlinecourses.nptel.ac.in/noc24_ee75/preview
2. https://rahsoft.com/courses/rf-engineeer-design-theory-and-principles-rahrf201/
3. https://www.coursera.org/learn/rf-mmwave-circuit-design

Course Code: 23EAT703		Course Title: Millimeter Wave Communication	
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) :3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives: This course focuses on the basic beam forming and antenna topologies for mmWave communication. This course explains the circuits, parameters and different mmWave principles.

Module I **23 Hours**

Radio Wave Propagation for MmWave-Large-Scale Propagation Channel Effects-Log-Distance Path Loss Models-Atmospheric Effects-Ray Tracing and Site-Specific Propagation Prediction-Small-Scale Channel Effects-Spatial Characterization of Multipath and Beam Combining-Angle Spread and Multipath Angle of Arrival-The On-Chip Antenna Environment-Antenna Topologies for MmWave Communications-Case Studies of Adaptive Arrays for MmWave Communications

Module II **22 Hours**

Analog Devices and Circuits: Concepts for MmWave Transistors and Devices-S-Parameters, Z-Parameters, Y-Parameters, and ABCD-Parameters-Advanced Models for MmWave Transistors-Analog MmWave Components-Trends and Architectures for MmWave Wireless ADCs-MmWave Standardization-60 GHz Spectrum Regulation-IEEE 802.15.3c-WiGig

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1 : Implement a beamforming system using a specified antenna array configuration to achieve targeted radiation patterns for a wireless communication application.	Apply
CO 2 : Analyze the performance of different mmWave communication standards (e.g., 5G NR, WiGig) in a simulated urban environment, considering factors like data rate, coverage, and interference.	Analyze
CO 3 : Analyze the case studies of antenna array system and make an oral presentation as team (for internal assessment only).	Analyze
CO 4: Analyze the trade-offs between different architectures for mmWave Wireless ADCs in terms of their performance metrics	Analyze
CO 5: Design and simulate a fundamental mmWave analog component using appropriate transistor models and S-parameter analysis in a simulation environment, considering the impact of transistor characteristics and operating frequency using modern tools.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	3	2	-	-	-	3
CO4	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO5	-	-	3	-	2	-	-	-	-	-	-	-	-	2

High-3; Medium-2;Low-1

Text Book(s):

T1. Theodore S.Rappaport. Robert W. Heath Jr. Robert C. Daniels, James N. Mudock, "Millimeter wave Wireless Communication", Pearson ,2015 Prentice Hall Communications Engineering and Emerging Technologies Series

T2. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

Reference Book:

1. Xiang, W.Zheng, K. Shen, X.S, "5G Mobile Communications", Springer, 2016.

Web References:

1. https://doi.org/10.3390/books978-3-03928-431-3

2. https://onlinecourses.nptel.ac.in/noc21_ee76/preview

Course Code: 23EAL701		Course Title: RF Circuit Design Laboratory	
Course Category: SEC		Course Level: Advanced	
L:T:P(Hours/Week) 0:0 :3	Credits: 1.5	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to provide students with a strong foundation in RF circuit design principles and practical skills, enabling them to analyze, design, and implement basic RF systems.

List of Experiments:

1. Characterize the frequency response of passive components (resistors, capacitors, inductors) at RF frequencies.
2. Measure the characteristic impedance, propagation constant, and attenuation of a coaxial cable using suitable technique
3. Design and implement an L-section matching network using a Smith chart using EM simulation tool.
4. Measure the S-parameters of a two-port network using a vector network analyzer.
5. Design and build a common-emitter amplifier using a BJT transistor using EM simulation tool.
6. Design and build a class AB power amplifier using a suitable transistor using EM simulation tool.
7. Design and build a class A power amplifier using a suitable transistor using EM simulation tool.
8. Design and build a Colpitts oscillator using EM simulation tool. Measure its oscillation frequency, output power, and stability.
9. Design and build a simple diode mixer using EM simulation tool. Measure its conversion gain and noise figure.
10. Design and build a bandpass filter using LC components. Measure and analyze its frequency response and insertion loss.
11. Design and build a bandstop filter using LC components. Measure and analyze its frequency response and insertion loss.
12. Design a simple microstrip line using EM simulation tool . Measure its characteristic impedance and compare it with the calculated value.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Conduct experiments to verify the characteristics of RF circuits and devices	Apply
CO 2: Simulate and conduct experiments in teams involving the design of RF circuits and measurements	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	1	-	-	-	3	-
CO2	-	3	-	-	3	-	-	-	3	-	-	-	3	-

Reference Book(s):

Lab manual prepared by the faculty of ECE department

Course Code: 23EAP701	Course Title: Project Phase - I		
Course Category: Project		Course Level: Advanced	
L:T:P (Hours/Week) 0: 0: 8	Credits: 4	Total Contact Hours:120	Max. Marks:100

Course Objectives:

The objective of the course is to enable students to identify and investigate real-world problems in the field of Electronics and Advanced Communication Technologies, and develop innovative solutions. It focuses on designing and implementing a functional software or hardware prototype.

Module:

Understanding research domains and identifying a relevant problem statement - Conducting a thorough literature survey to study existing solutions and identifying research gaps - Defining clear project objectives and scope based on the problem analysis - Performing requirement analysis, including hardware/software needs and feasibility study - Planning project activities with appropriate time management tools - Designing the system architecture through block diagrams or flowcharts and selecting appropriate tools and technologies - Developing a methodology for implementation, including initial modeling or simulation - Executing partial implementation or subsystem development with a focus on performance analysis - Preparing interim reports with proper documentation, citation, and plagiarism compliance - Delivering an oral presentation to a review committee demonstrating the progress and understanding of the project work.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply the knowledge of Electronics and Advanced Communication Technologies to identify real-world problems through literature survey and gap analysis, considering societal, health, safety, legal, and cultural issues.	Apply
CO2: Analyze the functional and technical requirements to perform feasibility studies and prepare an effective project plan and bill of materials.	Analyze
CO3:Design a suitable system architecture or solution approach using appropriate hardware/software tools and simulation methodologies.	Create

CO4: Evaluate the performance and feasibility of the developed prototype/algorithm through structured documentation and individual oral presentation to justify the design choices.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	3	3	-	-	-	-	-	1	1
CO2	-	3	-	-	-	-	-	-	-	-	3	-	1	1
CO3	-	-	3	-	2	-	-	-	-	-	-	-	1	1
CO4	-	-	-	3	-	-	-	1	3	3	-	2	3	3

High-3; Medium-2; Low-1

SEMESTER VIII

Course Code: 23EAP801	Course Title: Project Phase - II		
Course Category:Project		Course Level: Advanced	
L:T:P (Hours/Week) 0: 0: 12	Credits:6	Total Contact Hours:180	Max. Marks:200

Course Objectives:

The course aims to equip students with the ability to identify and analyze engineering problems through literature review and research in the field of Electronics and Advanced Communication Technologies. It emphasizes developing innovative solutions through theoretical and practical work, including design, modeling, simulation, and prototyping. The course also focuses on enhancing project execution, documentation, and presentation skills for effective technical communication.

Module:

Identifying the project goals and finalizing the problem statement based on societal relevance and feasibility – Designing and developing a complete solution using appropriate hardware, software, or a combination of both – Implementing the system through coding, circuit design, simulation, fabrication, or prototyping – Testing and validating the developed solution through experiments, data collection, and analysis – Evaluating system performance using key parameters such as accuracy, speed, efficiency, and reliability – Making improvements based on test results to enhance functionality and robustness – Documenting the entire process with clear methodology, results, discussions, and conclusions – Ensuring ethical practices, sustainability, and safety compliance in the project – Preparing a professional technical report with references, diagrams, and outcome analysis – Presenting the completed work effectively through oral presentation and demonstration before an expert review panel.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Apply appropriate engineering concepts, tools, and technologies to implement a functional solution addressing a complex, real-world problem.	Apply
CO2: Analyze the performance and behavior of the implemented system under various testing conditions to identify limitations and areas for improvement.	Analyze

CO3: Evaluate the effectiveness, efficiency, and sustainability of the developed solution by comparing alternative designs and justifying the final approach with experimental data.	Evalate
CO4:Create a comprehensive technical report and demonstrate the completed project through a structured presentation, showcasing innovation, interdisciplinary integration, and potential future enhancements as a team.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	2	-	1	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	1
CO3	-	-	-	3	-	3	3	-	-	-	-	-	1	1
CO4	-	-	3	-	-	-	-	2	3	2	-	2	3	3

High-3; Medium-2; Low-1

NETWORKING ELECTIVES

Course Code: 23ECE001		Course Title: Cryptography and Network Security (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits: 3	Total Contact Hours:45	Max Marks: 100

Course Objectives:

This course aims to provide a solid foundation in cryptographic algorithms and network security, focusing on encryption techniques, public key cryptography, authentication protocols, and system-level security mechanisms.

Module I **22 Hours**

Cryptographic Algorithms: Security goals – Cryptographic attacks- services and mechanisms- classical encryption techniques- Block Cipher Design Principles and modes of operation – Data Encryption Standard – Triple DES- Advanced Encryption Standard.

Number theory and Public Key Cryptography: Prime Numbers, Fermat and Euler's theorem, testing of primality, Chinese Remainder Theorem, Quadratic Congruence, Exponentiation and Logarithm- Public Key Cryptography and RSA- Key management: Diffie –Hellmann Key Exchange, Elliptic Curve Cryptography.

Module II Network and System Level Security **23 Hours**

Authentication and Hash Function: Authentication requirements - Authentication functions - Message Authentication Codes – Hash Functions –Security in Hash Functions and MACS- Applications of Hash Functions – MD5 Message Digest Algorithm – Hash Algorithm.

Network and System Level Security: Kerberos – X.509 Authentication Service – Electronic Mail Security- PGP – S/MIME – IP Security – ISAKMP- Worms, Viruses, Intrusion Detection System(IDS)- Firewall Design Principles, Cyber-attacks: Brute force attack, Denial of Service (DoS), IP Spoofing attack.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Demonstrate encryption techniques using DES, Triple DES, and AES to achieve security goals and counter cryptographic attacks.	Apply
CO 2: Apply the concept of number theory to implement cryptographic algorithms	Apply
CO 3: Analyze the role of hash and MAC function in cryptographic protocols	Analyze
CO 4: Apply appropriate security protocols to safeguard Cognitive Radio Networks against various types of attacks and assess their effectiveness in dynamic spectrum environments.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. William Stallings, Cryptography and Network Security – Principles and Practice, Prentice Hall of India, 3rd Edition, 2003

T2. Behrouz A Forouzan, Cryptography and Network Security, Tata McGraw Hall, 2nd Edition, 2011

Reference Book(s):

R1. Atul Kahata, Cryptography and Network Security, Tata McGraw-Hill,2003

R2. Bruce Schneier, Applied Cryptography Protocols, Algorithms and Source Code in C

R3.Charles P.Pfleeger, Shari Lawrence Pfleeger, Security in Computing, 3rd Edition, Pearson Education,2003

Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105162/
2. https://onlinecourses.nptel.ac.in/noc22_cs03/preview
3. https://archive.nptel.ac.in/courses/106/107/106107155/

Course Code: 23ECE002		Course Title: Wireless Networks (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course aims to provide a comprehensive understanding of wireless networks, focusing on protocol stacks, standards, and network layer solutions. Students will analyze 3G services and their applications, explore the integration of WLAN and WWAN, and study the evolution and architecture of 4G networks. Through this curriculum, learners will gain the skills necessary to navigate and innovate in the field of wireless networks.

Module I **23 Hours**

Wireless LAN : Introduction-WLAN technologies: - IEEE802.11: System architecture, protocol architecture, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, WPAN – IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, Wireless HART.

Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol, mobile ad-hoc network: Routing: Destination Sequence distance vector, IoT: CoAP.

3GPP Architecture, User equipment, CDMA2000 overview- Radio and Network components, Network structure, Radio Network, TD-CDMA, TD – SCDMA.

Module II **23 Hours**

Internetworking between WLANS and WWANs: Internetworking objectives and requirements, Schemes to connect WLANS and 3G Networks, Session Mobility, Internetworking Architecture for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution System.

4G & Beyond: 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO. Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify and choose wireless transmission standard, physical layer protocol and MAC layer protocol on the basis of various network applications.	Understand
CO 2: Determine the the key concepts involved in wireless wide-area networks and its architecture.	Apply
CO 3: Design and Analyze various smart antennas with various modulation and coding techniques used in 4G technology	Analyze
CO4 : Apply configuration, operation, and performance analysis techniques to WLAN, Wi-Fi, ZigBee, and LTE networks .	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Jochen Schiller, ”Mobile Communications”, Second Edition, Pearson Education 2012.

T2. Vijay Garg, “Wireless Communications and networking”, First Edition, Elsevier 2007.

Reference Book(s):

R1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband”, Second Edition, Academic Press, 2008.

R2. Anurag Kumar, D.Manjunath, Joy kuri, “Wireless Networking”, First Edition, Elsevier 2011.

R3. Simon Haykin , Michael Moher, David Koilpillai, “Modern Wireless Communications”, First Edition, Pearson Education 2013

Web References:

1. https://www.sciencedirect.com/topics/computer-science/wireless-networks

2.https://www.springer.com/series/14180?srsltid=AfmBOoqZEeE8qUi0Qt_Rc8gIunWDGCLnv8LdCh3nx9nd0n4rwxc1H8f

Course Code: 23ECE004		Course Title: Cyber Forensics and Information Security (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the principles and processes of cyber forensics, including evidence acquisition, investigation techniques, and the use of forensic tools. Emphasis is placed on understanding digital evidence, forensic technologies, and maintaining the chain of custody during investigations.

Module I **23 Hours**

Introduction to Cyber Crime: Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime. Role of ECD and ICT in Cybercrime - Classification of Cyber Crime. Cyber Forensics -Steps in Forensic Investigation - Forensic Examination Process - Types of CF techniques - Forensic duplication and investigation - Forensics Technology and Systems - Understanding Computer Investigation – Data Acquisition.

Evidence Collection, Forensics Tools and Ethical hacking: Processing Crime and Incident Scenes – Digital Evidence - Sources of Evidence -Working with File Systems - Registry - Artifacts - Current Computer Forensics Tools: Software/ Hardware Tools - Forensic Suite - Acquisition and Seizure of Evidence from Computers and Mobile Devices - Chain of Custody- Forensic Tools - Introduction to Ethical Hacking - Foot printing and Reconnaissance - Scanning Networks – Enumeration - System Hacking - Malware Threats – Sniffing – Email Tracking

Module II **22 Hours**

Introduction to information systems and security: Information Systems (IS) - Types of IS: Operations Support Systems, Management Support Systems, Knowledge based Systems – Development of IS: Waterfall model, Prototyping model, Evolutionary model - Spiral model, Incremental model - Need for IS – Threats to IS

Cyber Security: Protection for Applications and Individual Privacy- Security Risk analysis – Application security and counter measures – Security technologies: firewall, VPN, intrusion Monitoring and Detection, Security threats in E-commerce.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the effectiveness of different forensic tools and methods used in digital evidence collection and analysis.	Understand
CO 2: Apply ethical hacking techniques such as foot printing, scanning, and system enumeration to assess vulnerabilities and propose basic countermeasures to mitigate cybersecurity threats.	Apply
CO 3: Analyze different types of cybercrimes and evaluate the role of ICT and ECD in facilitating or combating cybercrime through real-world case studies and scenarios.	Analyze
CO 4 : Analyze threats to information systems and assess security risks to develop appropriate application security and privacy protection strategies using tools like firewalls, VPNs, and intrusion detection systems.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	2	-	-	2	-	-	-	-	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Murugan, S.. Cyber Forensics. Canada, Oxford University Press, 2018.

T2. V. S. Bagad, I. A. Dhotre and Manish Khodaskar, “Information and Cyber Security”, Technical Publications, 2nd Edition, 2019.

Reference Book(s):

R1. Surya Prakash Tripathi, RitendraGoel and Praveen Kumar Shukla, “Introduction to Information Security and Cyber Laws”, Dreamtech Press, 1st Edition, 2014

R2. Nishesh Sharma, “Cyber Forensics in India: A Legal Perspective”, Universal Law Publishing, 1st Edition, 2017.

R3. Sarika Gupta and Gaurav Gupta, “Information Security and Cyber Laws”, Khanna Publishing, 1st Edition, 2011.

Web References:

1. https://onlinecourses.swayam2.ac.in/cec24_ge04/preview
2. https://intellipaat.com/blog/what-is-cyber-forensics/
3. https://www.youtube.com/watch?v=0vvUkancccU

Course Code: 23ECE005		Course Title: High Speed Networks (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on comprehensive understanding of the principles and architectures of high-speed networks by exploring various networking protocols, and optimize the network resource allocation to reduce congestion.

Module I **22 Hours**

High Speed Networks: Frame Relay Networks & Asynchronous transfer mode. ATM Protocol: Architecture, ATM logical Connection, ATM Cell, ATM Service Categories, AAL. High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel. Wireless LANs: Architecture of 802.11.

Congestion and Traffic Management: Queuing Analysis, Single Server Queues, Congestion Control, Traffic Management-Congestion Control in Packet Switching Networks, Frame Relay Congestion Control. TCP Congestion Control: TCP Flow control & Congestion Control, KARN's Algorithm, Window management, Performance of TCP over ATM. Traffic and Congestion control in ATM: Requirements, Traffic Management Frame work, ABR traffic Management, ABR rate control, RM cell formats, ABR Capacity allocations.

Module II **23 Hours**

Integrated and Differentiated Services: Architecture – Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ, Random Early Detection, Differentiated Services.

Protocols for QoS Support: RSVP - Data Flow, RSVP operations, Protocol Mechanisms & Multiprotocol Label Switching, Label Stacking. RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Describe ATM and Frame relay operation of high speed networks	Understand
CO2: Apply the principles of high-speed and wireless LAN technologies, including Fast Ethernet, Gigabit Ethernet, Fibre Channel, and IEEE 802.11 architectures, to evaluate network performance in high-speed environments.	Apply
CO2: Implement TCP and ATM Congestion Control Techniques using algorithms and traffic management techniques.	Apply
CO3: Analyze queuing models for congestion and traffic management using congestion control techniques	Analyze
CO4: Apply Quality of Service (QoS) protocols to support the performance requirements of various network applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2; Low-1

Text Books:

T1. William Stallings, “High Speed Networks and Internet”, Pearson Education, 2nd Edition, 2002.

T2. Uyless Black: MPLS and Label Switching Networks, Pearson Education, 2nd Edition, 2001.

Reference Books:

R1. Jean Walrand, Pravin Pratap Varaiya, “High performance communication networks”, 2nd Edition, Jean Harcourt Asia Pvt. Ltd., 2001.

R2. Irvan Pepelnjk, Jim Guichard, Jeff Apcar, “MPLS and VPN architecture”, Cisco Press, Volume I and II, 2003.

R3. Sumit Kasera and Pankaj Sethi, “ATM Networks Concepts and Protocols”, 2nd Edition, Tata McGraw-Hill- New Delhi, 2006.

Web References:

1.http://nptel.ac.in/courses/106105081/1

2.http://nptel.ac.in/courses/106105082/30

Course Code: 23ECE006		Course Title: Data Communication Networks (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on various network topologies and protocols by examine network design principles including switching, routing, congestion control and develop critical skills to troubleshoot and optimize data communication networks.

Module I **22 Hours**

Networks models: OSI model – TCP / IP protocol suite – Addressing – Transmission Media: Twisted pair, Coaxial Cable – Error detection: Parity Checks, Cyclic Redundancy Check (CRC)- Framing – Flow Control and Error control techniques: Stop and wait – Go back N ARQ – Selective repeat ARQ – sliding window techniques – Multiple Access Techniques: Random access protocol, Controlled access protocol – Ethernet: IEEE 802.3 – Wireless LANS: IEEE802.11-Network performance metrics

Module II **23 Hours**

Internetworking devices: hub, repeater, bridge, switch, router, Gateway – Basic Internetworking (IP, ARP, DHCP, ICMP), IPV4, IPV6 – Routing: Link State Routing, Distance Vector Routing-Process – to – Process delivery- User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control -Quality of services (QoS) – Techniques to improve QoS– Integrated Services – Differentiated Services. Traditional Applications: Domain Name System (DNS) – E-mail (MIME, SMTP, POP3, IMAP) – WWW – HTTP – SNMP – Telnet

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the layers of OSI model with TCP/IP protocol suite using their functions	Understand
CO 2: Apply the congestion control algorithms in Communication Networks to improve the quality of service	Apply
CO 3: Design a custom network routing solution by integrating appropriate protocols and algorithms.	Apply
CO 4: Analyze the Application layer services based on its protocols.	Analyze
CO 5: Use network simulation tools like Packet tracer or Wireshark to set up and analyze network traffic and performance metrics as a team. (for Internal assessment only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-		2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	3	1	-	-	3	-

High-3; Medium-2;Low-1

Text Books:

T1. Behrouz A. Forouzan, “Data communication and Networking”, 4 th edition, Tata McGraw- Hill, 2007

T2. James .F. Kurose & Keith W. Ross, “Computer Networking: A Top down Approach Featuring the Internet”, 3rd Edition, Pearson Education, 2007

Reference Books:

R1. Larry L.Peterson and Peter S. Davie, “Computer Networks” 4th edition, Harcourt Asia Pvt. Ltd, 2007.

R2. Wayne Tomasi, “Introduction to Data Communication and Networking”, 1st Edition, Pearson Education, 2007.

R3. William Stallings, “Data and Computer Communication”, 8th Edition, Pearson Education, 2007.

Web References:

1.https://nptel.ac.in/courses/106105183

2.https://www.cse.iitk.ac.in/users/dheeraj/cs425/

3.https://ocw.mit.edu/courses/6-263j-data-communication-networks-fall-2002/pages/lecture-notes/

Course Code: 23EAE001		Course Title: Bluetooth technology	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course aims to provide students with a foundational understanding of Bluetooth technology, including its basic operations and protocols. Students will learn to classify Bluetooth protocols, analyze key operational parameters, and understand the functions of the Logical Link Control and Adaptation Protocol (L2CAP). Additionally, the course will cover various security methods, evaluating their effectiveness in protecting data and privacy in Bluetooth applications.

Module I **22 Hours**

Bluetooth: Origin and Advantages – Technology – Topology – Problems - Basic Concepts: Spread Spectrum - Circuit and Packet Switching - Time Division duplexing - Physical Links - Peeking into Packets - Bluetooth Packets - Logical Channels - Client Server Architecture - Service Discovery.

Bluetooth Protocol Architecture: Bluetooth network Architecture - Open System Interconnection - Bluetooth Protocol Stack - Bluetooth core Protocols - Cable Replacement Protocols - Adopted Protocols - Usage Models and Profiles.

Module II **23 Hours**

Types of PDUs - Authentication – Pairing - Changing the Link Key – Encryption - Clock offset request - Timing accuracy information Request - LMP version - Switching of Master-Slave Role - Name Request - Detach - Hold mode - Sniff mode - Park Mode.

Logical Link Control: L2CAP Functions: Basic operation - State Machine - Data packet format – Signaling - Configuration Parameter Options - Service primitives.

Bluetooth Security Modes: Link level security – Implementation - Architecture overview - Security level of Services - Connection setup - Connectionless L2CAP - Security Manager - Interface to L2CAP - Interface to other Multiplexing Protocols. App Development.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply fundamental Bluetooth concepts such as spread spectrum, duplexing, and packet formats to understand wireless data communication and topology structure.	Apply
CO2: Analyze the Bluetooth protocol stack, core protocols, and adopted protocols to determine their functionality within various usage models and profiles.	Analyze
CO3: Apply Bluetooth protocol operations such as authentication, encryption, pairing, and power-saving modes to configure secure and efficient connections.	Apply
CO4: Analyze the role of L2CAP and Bluetooth security architecture to evaluate connection setup, logical link control, and application layer communication.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Books:

T1. Nathan J Muller, “Bluetooth Demystified”,1st Edition, Tata McGraw-Hill, New Delhi, 2001.

T2. Brent A. Miller, Chatschik Bisdikian “Bluetooth Revealed”, 2nd Edition, Prentice Hall, 2001

Reference Books:

R1. Jennifer Bray and Charles F. Sturman, “Bluetooth 1.1 Connect without Cables”, 2nd edition, Prentice Hall, 2006.

R2. Christian Gehrmann, Joakim Persson, Ben Smeets, “Bluetooth security”, 1st edition, Arch tech House Inc, 2004.

R3. C.S.R.Prabhu, A.Prathap Reddi, “Bluetooth Technology and its Applications with Java and J2ME”, 1st edition, Prentice -Hall of India Private Limited, New Delhi, 2004

R4. Robert Morrow, “Bluetooth operation and Use”, 1st edition, McGraw-Hill, 2002.

Web References:

1. http://www.nptel.ac.in/courses/106105080
2. http://www.engineersgarage.com/articles/bluetooth-technology
3. http://searchmobilecomputing.techtarget.com/definition/Bluetooth

RF COMMUNICATION ELECTIVES

Course Code: 23ECE007		Course Title: Electromagnetic Interference and Compatibility (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the EMI sources, EMI problems and their solutions at PCB level, and also to understand sub system level design and to measure the emission, immunity level from different systems to couple with the prescribed EMC standards.

Module I **22 Hours**

EMI/EMC Concepts

Definition of EMI and EMC with examples, Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes – CM and DM, ESD Phenomena and effects, Transient phenomena and suppression.

EMI Measurements

Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique open area site, shielded anechoic chamber, TEM cell.

EMI Control Methods and Fixes

Shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator.

Module II **23 Hours**

EMC Standards and Regulations

National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, Frequency assignment - spectrum conversation.

EMC Design and Interconnection Techniques

Cable routing and connection, Component selection and mounting, PCB design- Trace routing, Impedance control, decoupling, Zoning and grounding.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the fundamental principles, sources, and coupling mechanisms of EMI and their effects on electronic systems.	Understand
CO 2: Apply EMI troubleshooting techniques to identify and mitigate EMI problems in electronic circuits and systems.	Apply
CO 3: Analyze EMI measurement techniques and tools to interpret emission and susceptibility data in practical scenarios.	Analyze
CO 4: Analyze and present as team, a report on EMC standards, frequency assignment, and spectrum conservation practices.(For Internal Assessment only)	Analyze
CO5: Evaluate EMI control strategies by applying EMC design techniques to minimize electromagnetic interference in electronic systems	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-		-
CO4	-	3	-	-	-	-	-	-	2	3	-	-	3	-
CO5	-		-	3	-	-	-	-	-	-	-	2	-	-

High-3; Medium-2;Low-1

Text Books:

T1. Prasad Kodali.V, “Engineering Electromagnetic Compatibility” S.Chand&Co, New Delhi, 2000

T2. Clayton R.Paul, “Introduction to Electromagnetic compatibility”, Wiley & Sons, 1992

Reference Books:

R1. Keiser, “Principles of Electromagnetic Compatibility”, 3rd ed., , Artech House, Norwood, 1986.

R2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 9.

R3. Henry W.Ott.,”Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.

Web References:

1. https://archive.nptel.ac.in/courses/108/106/108106138/
2. https://onlinecourses.nptel.ac.in/noc24_ee67/preview
3. http://courseware.cutm.ac.in/courses/electromagnetic-compatibility/

Course Code: 23ECE010		Course Title: Ultra Wideband Communication (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week)::3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives: This course focuses on the basic signal processing techniques that concerns present and future dynamic UWB communication systems. This course encompasses all areas of design and implementation of UWB systems.

Module I **22 Hours**

Signals and Systems with UWB Waveforms: Introduction – Power spectral density – Pulse shape – Pulse trains – Spectral masks – Multipath – Penetration characteristics – Spatial and spectral capacities – Speed of data transmission – Gaussian waveforms. Effects of a lossy medium on a UWB transmitted signal – Time domain analysis – Frequency domain techniques. UWB modulation methods- Multiple access techniques in UWB – Capacity of UWB systems-Applications of UWB communication systems.

Module II **23 Hours**

Antenna radiation for UWB signals – Conventional antennas and Impulse antennas for UWB systems – Beamforming for UWB signals - Radar UWB array systems – Wireless positioning and location – GPS techniques – Positioning techniques – Time resolution issues – UWB positioning and communications. UWB standardization in wireless personal area networks-– IEEE proposals for UWB channel models-MIMO and Space-time coding for UWB systems .

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1 : Apply the concepts of power spectral density, pulse shaping, pulse trains, spectral masks, and Gaussian waveforms for UWB signals.	Apply
CO 2 : Implement time-domain and frequency-domain techniques to assess the effects of a lossy medium on UWB signal transmission.	Apply
CO 3 : Apply UWB modulation and multiple access methods to evaluate system capacity, penetration, multipath handling, and data rate performance in communication environments.	Apply

CO 4 : Analyze the characteristics of conventional and impulse antennas, and examine beamforming and radar array configurations used for UWB signal transmission.	Analyze
CO 5 : Examine UWB-based wireless positioning techniques, IEEE channel models, GPS integration, and MIMO-space time coding standards in WPANs.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. M. Ghavami, L. B. Michael and R. Kohno, “Ultra Wideband signals and systems in Communication Engineering”, 2nd Edition, John Wiley & Sons, NY, USA, 2007.

T2. Jeffrey H. Reed, “An Introduction to Ultra Wideband Communication systems”, Prentice Hall Inc., NJ, USA, 2012.

Reference Book(s):

1. Maria-Gabriella Di Benedetto , “UWB Communication Systems: A Comprehensive Overview”, Hindawi Publishing Corporation,2006

2. Faranak Nekoogar,” Ultra-Wideband Communications: Fundamentals and Applications” Pearson,2006

Web References:

1. https://www.koenig-solutions.com/ultra-wideband-uwb-technology-training
2. https://niccs.cisa.gov/education-training/catalog/tonex-inc/introduction-ultra-wideband-uwb

Course Code: 23ECE011		Course Title: RF Transceivers (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on fundamentals and basic techniques needed for analysis of RF systems, acquaint with the various components of RF system for wireless communications

Module I **22 Hours**

CMOS: Introduction to MOSFET Physics - Noise: Thermal, shot, flicker, popcorn noise. Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR - Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low-IF Architectures - Transmitter: Direct-up conversion, Two-step up conversion schemes

Impedance Matching Networks: Review of S-parameters and Smith chart - Passive IC components - Impedance matching networks

Amplifiers: Common Gate, Common Source Amplifiers - OC Time constants in bandwidth estimation and enhancement - High frequency amplifier design - Low Noise Amplifiers: Power match and Noise match, single-ended and differential LNAs

Feedback Systems: Stability of feedback systems, Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation.

Module II **23 Hours**

Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers - Linearization Techniques - Efficiency boosting techniques - ACPR metric

Filters: Overview - basic resonator and filter configuration, special filter realizations, filter implementation

Oscillators: Basic oscillator model, high-frequency oscillator configuration, Colpitt's oscillator. basic characteristics of mixers, single and double-balanced mixers

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge pumps

Frequency Synthesizers: Integer-N frequency synthesizers - Direct Digital Frequency Synthesizers

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Interpret the nonlinear effects in RF circuits	Understand
CO 2: Apply knowledge to identify a suitable architecture and systematically design an RF System	Apply
CO 3: Design RF circuits like amplifiers, filters, mixers	Analyze
CO 4: Analyze the performance of RF circuits	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Lee T, Design of CMOS RF Integrated Circuits, Cambridge, Second Edition, 2004

T2. Razavi B, RF Microelectronics, Pearson Education, Second Edition, 2012

Reference Book(s):

R1. Ludwig R, and Bretchko P, RF Circuit Design Theory and Applications, Prentice Hall, 2000

R2. Razavi B, Design of Analog CMOS Integrated Circuits, McGraw Hill, Second Edition, 2017

R3. Kyung-WhanYeom, Microwave Circuit Design - A Practical Approach using ADS, Pearson Education, 2015

Web References:

1. https://nptel.ac.in/courses/108107379

2. https://archive.nptel.ac.in/courses/117/102/117102012/

Course Code: 23ECE012		Course Title: Cognitive Radio Network (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the basics of Software Defined Radio, Cognitive Radio architecture, their technologies and analyze the impact of interference in Cognitive Radio.

Module I **22 Hours**

Need for software defined radio, definition, characteristics and benefits of SDR, design principles of SDR, The ideal Software Radio- The Software Radio Functional Architecture. Basic SDR-hardware architecture, computational processing resources, software architecture, Spectrum management. Brief concept of Cognitive Radio-Definition, Function and applications of CRN, Policy challenges: Dynamic spectrum access, Security- Available Technologies for CRs

Module II **23 Hours**

Cognitive Radio Architecture: Functions, components and design rules: AACR Functional component Architecture-Design rules-Flexible functions of component Architecture, Cognition cycle: observe, orient, plan, decide and act phases. Spectrum Awareness: Interference avoidance problem, cognitive radio role, spectrum sensing, Channel awareness and multiple signals in space, adaptive spectrum implications for Cognitive Radio hardware

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Recognise the basics of the Software defined Radio and Cognitive Radio networks using their functional architecture	Understand
CO 2: Analyze the functional architecture, design principles, and cognition cycle of cognitive radios.	Analyze
CO 3 : Examine spectrum awareness techniques including interference avoidance, channel sensing, and adaptive hardware implications.	Analyze

CO 4: Apply GNU Radio's architecture to implement any one of modulation and demodulation technique using simulation tool and give an oral presentation (For Internal Assessment only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	3	-	-	-	-	2	-	-	3	-

High-3; Medium-2;Low-1

Text Books:

T1. Bruce A. Fette, “Cognitive Radio Technology”, Elsevier, 2009.

T2. Software Radio: A Modern Approach to Radio Engineering by Jeffrey H. Reed Pearson Education, 2002

Reference Books:

R1. Joseph Mitola III, “Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering”, John Wiley and Sons Ltd.2000.

R2. Markus Dillinger, KambizMadani, Nancy Alonistiotic,” Software Defined Radio”, John Wiley, 2003.

R3. Alexander M. Wyglinski, Maziarnekovee, Y.ThomasHu,”Cognitive Radio Communication and Networks”, Elsevier, 2010.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ee78/preview
2. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4644051
3. http://link.springer.com/chapter/10.1007/978-1-4020-5542-3_2

Course Code: 23EAE002		Course Title: Error control Coding Techniques	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge and skills to design, analyze, and implement modern error correcting codes for reliable data transmission and storage

Module I **22 Hours**

Coding Theory: Introduction to information theory, Shannon Theorems, Channel models, Hamming Distance

Linear Codes: Definition of Linear Codes, Generator Matrices, the Standard Array, Parity - Check Matrices, Error Syndromes, Error Detection and Correction, Shortened and Extended Linear Codes.

Block Codes: Introduction to Block Codes, Single Parity Check Codes, Product Codes, Repetition Codes, Hamming Codes, Soft - Decision Decoding.

Module II **23 Hours**

Cyclic Codes: Definition of Cyclic Codes, Polynomials, Generator Polynomials, Encoding Cyclic Codes, Decoding Cyclic Codes, Factors of XN +1, Parity-Check Polynomials, Dual Cyclic Codes, Generator and Parity-Check Matrices of Cyclic Codes, Error Detection and Correction of cyclic codes.

BCH and RS Codes: Review on Linear Algebra, Galois Field, Definition and Construction of Binary BCH Codes, Error Syndromes in Finite Fields, Decoding- Single Error Correction (SEC) and Double Error Correction (DEC), Reed- Solomen Codes.

Convolution Codes: Convolution, Encoding Convolutional Codes, Generator Matrices for Convolutional Codes, Generator Polynomials for Convolutional Codes, Graphical Representation of Convolutional Codes, the Viterbi Decoder.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Interpret the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.	Understand
CO 2: Apply mathematical tools from group and finite field theory in the design of codes.	Apply
CO 3: Construct the codes capable of correcting and detecting a specified number of errors.	Analyze
CO 4: Develop an error correcting code for a given application	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	3	-	-	-	-	-	-	-	-	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Moreira Jorge Castineira, Farrell Patrick Guy, “Essentials Of Error Control Coding”, Wiley India, 2013.

T2. Gravano Salvatore, "Introduction to Error Control Codes", Oxford University Press, 1st Edition, 2007.

Reference Book(s):

R1. . Ranjan Bose, “Information Theory, Coding and Cryptography”, 2nd Edition, TMH, 2009.

R2. Lin Shu; Costello Daniel J, “Error Control Coding : Fundamentals And Applications”, Pearson, 2011

R3. Sklar Bernard,"Digital Communications - Fundamentals and Applications", Pearson Education-LPE, 2nd Edition, 2009.

Web References:

1.https://nptel.ac.in/courses/117/104/117104121/

2. https://nptel.ac.in/courses/117/106/117106031/

Course Code: 23EAE003		Course Title: Electromagnetic Metamaterials	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on fundamental concepts of metamaterials and its various applications such as antennas, cloaking devices, and filters. Students will be equipped with the knowledge and skills to contribute to the cutting-edge research and development of metamaterial-based technologies.

Module I **22 Hours**

Introduction Definition of Metamaterials (MTMs) and Left-Handed (LH) MTMs, Theoretical Speculation by Viktor Veselago, Experimental Demonstration of Left-Handedness, Conventional Backward Waves and Novelty of LH MTMs, Terminology, Transmission Line (TL) Approach, Composite Right/Left- Handed (CRLH) MTMs, Left-Handedness from Maxwell's Equations, Boundary Conditions, Reversal of Doppler Effect, Reversal of Snell's Law: Negative Refraction.

TL Theory of MTMs Ideal Homogeneous CRLH TLs: Fundamental TL Characteristics, Equivalent MTM Constitutive Parameters, Balanced and Unbalanced Resonances, Lossy Case, LC Network Implementation, Difference with Conventional Filters, Transmission Matrix Analysis, Input Impedance, General Design Guidelines, Microstrip Implementation, Parameters Extraction, Conversion from Transmission Line to Constitutive Parameters.

Module II **23 Hours**

An overview of different types of SRR and CSRR, Equivalent circuit model for MSRR, Labyrinth and spiral resonator, Parameters extraction using NRW approach, Applications of SRR, CSRR .

Guided-Wave Applications - Dual-Band Components: Dual-Band Property of CRLH TLs - QuarterWavelength TL and Stubs - Passive Component Examples: Quadrature Hybrid and Wilkinson Power Divider - Enhanced-Bandwidth Components: Principle of Bandwidth Enhancement - Rat-Race Coupler Example.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the concept of negative permittivity and permeability and the theoretical basis of left-handed metamaterials.	Understand
CO 2: Apply transmission line theory to analyze the behavior of metamaterials, including the design and analysis of composite right/left-handed (CRLH) transmission lines.	Apply
CO 3 : Analyze the performance of various metamaterial structures	Analyze
CO 4: Examine the passive component design ,bandwidth enhancement techniques .Individually or as team, deliver the research findings and design methodologies to the class .	Analyze
CO 5: Experiment any metamaterial-based component using electromagnetic simulation software (e.g., CST Microwave Studio, HFSS, ADS) (For internal assessment only)	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	3	-	-	-	-	-	-	2	2	-	-	2	-
CO5	-	3	-	-	3	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Christophe Caloz, Tatsuo Itoh, “Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications “by John Wiley & Sons, Inc., Hoboken, New Jersey, 2006.

T2. Ricardo Marqués, Ferran Martín, Mario Sorolla, Metamaterials with Negative Parameters: Theory, Design, and Microwave Applications, Wiley, Inc.,2008

Reference Book(s):

R1. Filippo Capolin, Theory and Phenomena of Metamaterials, CRC Press, 2009

R2. S. A. Ramakrishna and T. M. Grzegorczyk, Physics and Applications of Negative Refractive Index Materials, CRC Press, Taylor & Francis Group and SPIE Press, 2009.

R3. G. V. Eleftheriades and K. G. Balmain, Negative Refraction Metamaterials: Fundamental Principles and Applications, Copyright: IEEE, John Wiley & Sons, Inc., Hoboken, New Jersey, 2005.

Web References:

1. www.everythingrf.com
2. https://archive.nptel.ac.in/courses/112/107/112107290/
3. https://pubs.rsc.org/en/content/articlelanding/2011/cs/c0cs00184h

VLSI
ELECTIVES

Course Code: 23ECE020		Course Title: Low Power VLSI Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week)3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on physics of power dissipation in CMOS devices, estimation of power, synthesis for low power, design of low voltage CMOS Circuits, low power static RAM architectures and computation of low energy.

Module I **23 Hours**

Power Dissipation in CMOS:

Sources of Power Dissipation, MIS Structure, Long-Channel MOSFET, Submicron MOSFET, Gate-Induced Drain Leakage, Short-Circuit Dissipation, Dynamic Dissipation, Load Capacitance, Principles of Low-Power Design, Device Limits, Circuit Limits.

Power Estimation:

Modeling of Signals, Signal Probability using Binary Decision Diagrams, Switching Activity in Combinational Logic and Sequential Circuits, Estimating average power in Combinational Circuits and Sequential Circuits,

Module II **22 Hours**

Low Power Synthesis and Low-Voltage CMOS Circuits:

Behavioral Level Transforms for Low Power, Logic Level Optimization for Low Power, Circuit Level Transforms, Circuit Design Style, Leakage Current in Deep Submicrometer Transistors

Low Power Static RAM Architectures and Low-Energy Computing:

Organization of static RAM, MOS Static RAM Memory Cell, Banked Organization of SRAMs, Reducing Voltage Swings on Bit Lines, Reducing Power in Write Driver Circuits and Sense Amplifier Circuits. Energy Dissipation in Transistor Channel using an RC Model, Energy Recovery Circuit Design.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply techniques for minimizing power dissipation in CMOS devices	Apply
CO2. Model signals and estimate power in combinational circuits and sequential circuits.	Apply
CO3. Apply the different transforms for low power and model low voltage CMOS Circuits.	Apply
CO4. Analyze low power static RAM architectures and energy recovery circuits.	Analyze

Course Articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	3	-	-	-	-	-	-	2	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	3

High-3; Medium-2;Low-1

Text Book(s):

T1. Koushik Roy, Sharat Prasad , “Low-Power CMOS VLSI Circuit Design ”, Wiley & Sons ,2009 .

T2. Gary Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic Publishers , 1998.

Reference Book(s):

R1. Dimitrios, Soudris, Christians Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer Academic Publishers, 2002.

R2. Chandrasekaran, A.P., Broadersen. R.W, “Low Power Digital CMOS VLSI Design”, Kluwer Academic Publishers,1995.

Web References:

1. https://www.youtube.com/watch?v=TFOO1JAll2Y&list=PLBU5KursMXEMWAkoUPB5ac
2. https://www.youtube.com/playlist?list=PL018645397D9487AF

Course Code: 23ECE021		Course Title: ASIC Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course aims to provide students with a comprehensive understanding and analyze the different types of ASICs, Programmable ASIC logic cells, programmable ASIC I/O Cells and interconnect.

Module I **22 Hours**

Introduction to ASICs:

Types of ASICs – Full Custom ASICs, Standard Cell based ASICs, Gate-Array based ASICs, Channeled Gate Array, Channelless Gate Array, Structured Gate Array, Programmable Logic Devices, Field-Programmable Gate Arrays, Design Flow, ASIC Cell Libraries.

CMOS Logic and Programmable ASICs:

CMOS Transistors, CMOS Process, CMOS Design Rules, Combinational Logic Cells, Sequential Logic Cells, Datapath Logic Cells, I/O Cells, Cell Compilers, Programmable ASICs – Antifuse, Static RAM, EPROM and EEPROM Technology.

Module II **23 Hours**

Programmable ASIC Logic Cells:

Actel ACT – ACT1 Logic Module, Shannons Expansion Theorem, ACT2 and ACT3 Logic Modules, Xilinx LCA – XC3000 CLB, XC4000 Logic Block.

Programmable ASIC I/O Cells and Interconnect:

DC Output, AC Output, DC Input, AC Input, Clock Input, Power Input, Actel ACT, Xilinx LCA, Xilinx EPLD.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply various types of ASIC design methodologies.	Apply
CO 2: Examine CMOS logic and programmable ASICs.	Analyze
CO 3: Analyze programmable ASIC logic cells of ACT and Xilinx blocks.	Analyze
CO 4: Examine programmable ASIC I/O cells and interconnect architectures.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
C04	-	-	3	-	-	-	-	-	-	-	-	-	-	3

High-3; Medium-2;Low-1

Text Book(s):

T1. Michael John Sebastian Smith, "Application Specific Integrated Circuits", Pearson Education, 1997.

T2. Norman G. Einspruch, "Application Specific Integrated Circuit (ASIC) Technology", Academic Press, 2012.

Reference Book(s):

R1. Nigel Horspool, Peter Gorman "The ASIC Handbook", 3rd Edition, Prentice Hall Modern Semiconductor Design, India, 2001.

R2. John P.Huber, Mark W.Rosneck "Successful ASIC Design the First Time Through", Springer-Verlag New York, 2012.

Web References:

1. https://youtu.be/9Q9yIyNiAJQ?si=1YS_yVs1mMPwqJDg
2. https://www.youtube.com/watch?v=pcMi89GscwM
3. https://www.javatpoint.com/verilog-asic-design-flow

Course Code: 23ECE022		Course Title: CMOS Analog IC Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week)3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to impart knowledge on design of single stage and two stage CMOS amplifiers, frequency models of transistors and feedback amplifiers.

Module I **23 Hours**

MOS Transistors and CMOS Amplifier

Structure and Operation of MOSFET, MOS Device Models, PMOS Transistor, CMOS Amplifier Topologies – Common-Source stage with Current-Source Load, CS stage with Diode Connected load, CS stage with source degeneration, Common Gate Topology, Source Follower, Push Pull Amplifier.

Cascode Stages, Current Mirrors and Differential Amplifiers

Cascode Stage, MOS Current Mirror, Differential Signals, MOS Differential Pair, Cascode Differential Amplifiers, Common-Mode Rejection, Differential Pair with Active Load.

Module II **22 Hours**

Frequency Response

Relation between Transfer Function and Frequency Response, Bode's Rules, Association of Poles with Nodes, Miller's Theorem, High Frequency Models of Transistors, Frequency Response of CS,CG and followers.

Feedback Amplifiers and Operational Amplifiers

Voltage Amplifier, Transimpedance Amplifier, Transconductance Amplifier, Current Amplifier, Basic CMOS Op-Amp Design, Operational Transconductance Amplifier, Differential Output Op-Amp.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Use MOS transistor characteristics to construct and test CMOS amplifier circuits	Apply
CO2: Model current mirror and differential amplifier with different loads.	Apply
CO3: Analyze the frequency models of amplifier topologies.	Analyze
CO4: Analyze the performance and characteristics of feedback amplifiers and operational amplifiers, considering ethical implications and the sustainability of electronic system design	Apply

Course Articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	2	2	-	--	-	-	2	-	-	2	-	-	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Behzad Razavi, “Fundamentals of Microelectronics”, John Wiley and Sons, Second Edition, 2013.

T2.R.Jacob Baker, “CMOS Circuit Design ,Layout and Simulation”, Wiley, Fourth Edition 2019.

Reference Book(s):

R1. Behzad Razavi,”Design of Analog CMOS Integrated Circuits”, McGraw Hill, Second Edition, 2017.

R2. Adel S.Sedra, Kenneth C.Smith, Tony Chan Carusone, Vincent Gaudet, “Microelectronic Circuits”, Eighth edition, Oxford University Press, 2020.

Web References:

1. http://kcl.digimat.in/nptel/courses/video/117106030/L26.html
2. https://www.youtube.com/@sscdiitk
3. https://www.youtube.com/@b_razavi

Course Code: 23ECE023		Course Title: FPGA based System Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objective:

This course is intended to impart knowledge on various FPGA styles, circuit design and architecture of FPGA fabrics, physical design for FPGAs and architectures of multi-FPGA systems.

Module I **23 Hours**

FPGA based Systems and FPGA Styles:

FPGA Types, FPGA based System Design, FPGA Architectures, sRAM based FPGA-Logic Elements, Xilinx Spartan Combinational logic block, Interconnection Networks, Xilinx Spartan interconnect system, Configuration, JTAG Architecture, Xilinx Spartan configuration. Permanently Programmed FPGAs- Antifuses, Flash Configuration, Logic Blocks- Actel family logic elements, Interconnection Networks-Actel interconnect system, Chip I/O –Altera I/O pin.

Circuit Design and Architecture of FPGA Fabrics:

Circuit Design-Logic Elements, Interconnect. Architecture – Logic Element Parameters, Interconnect Architecture, Pinout.

Module II **22 Hours**

Logic Implementation and Physical Design for FPGAs:

Logic Implementation-Syntax-Directed Translation, Logic Implementation by Macro, Logic Synthesis, Logic Optimizations, Logic Synthesis. Physical Design – Placement, Routing.

Platform FPGAs and Multi-FPGA Systems:

Buses- Protocols and Specifications, Logic Design, Platform FPGA Architectures, Serial I/O, Memories. Muti-FPGA Systems- Constraints, Interconnecting Multiple FPGAs, Multi-FPGA Partitioning, Alternative FPGA Fabrics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1 : Apply the different styles of modeling in field programmable gate arrays	Apply
CO2 : Analyze circuit design and architecture of FPGA fabrics	Analyze
CO3 : Analyze logic optimization techniques and physical design considerations for FPGAs, evaluating their effectiveness using modern tools with attention to societal needs and sustainable design practices	Analyze
CO4 : Analyze the platform of FPGA architectures and multi-FPGA systems	Analyze

Course Articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	3	2	-	3	2	2	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	3

Text Book(s)

T1. Wayne Wolf, 'FPGA-Based System Design' Pearson Education, 2005.

T2. Clive "Max" Maxfield, "The Design Warriors's Guide to FPGAs", Elsevier, 2004.

Reference Book(s):

R1. Ian Grout, "Digital Systems Design with FPGAs and CPLDs", Elsevier Science, 2011.

R2. Pak K. Chan/Samiha Mourad, "Digital Design Using Field Programmable Gate Arrays", Pearson Low Price Edition, Jan 2009.

Web References:

1. https://www.eeweb.com/beginners-guide-to-understanding-fpga-development/
2. https://learn.sparkfun.com/tutorials/programming-an-fpga/all

Course Code: 23ECE024		Course Title: Testing of VLSI Circuits (Common to EA,EC)	
Course Category:Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to impart knowledge on various faults, test generation for combinational circuits, sequential circuits and BIST architectures.

Module I **23 Hours**

Faults in Digital Circuits and Test Generation for Combinational Logic Circuits:

Stuck-At Faults**,** Bridging Faults, Open Faults, Delay Faults**,** Fault Diagnosis, One-Dimensional Path Sensitization, Boolean Difference, D-Algorithm, Path-Oriented Decision-Making**,** Fanout-Oriented Test Generation, Delay Fault Detection**,** Detection of Multiple Faults in Combinational Logic Circuits.

Testable Combinational Logic Circuit Design:

Reed-Muller Expansion Technique, Three-Level OR-AND-OR Design, Testable Design of Multilevel Combinational Circuits, Path Delay Fault Testable Combinational Logic Design, Testable PLA Design.

Module II **22 Hours**

Test Generation and Design of Testable Sequential Circuits:

Testing of Sequential Circuits**,** State Table Verification, Test Generation based on Circuit and functional Fault Models**,** Controllability and Observability**,** Ad HoC Design Rules**,** Design of Diagnosable Sequential Circuits, Scan-Path Technique, Level-Sensitive Scan Design, Boundary Scan.

Built-In Self Test and Testable Memory Design:

Test Pattern Generation for BIST, Output Response Analysis, Circular BIST, BIST Architectures, LSSD On-Chip Self-Test, RAM Fault Models, Test Algorithms for RAMs, Detection of Pattern-Sensitive Faults.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Determine the faults in digital circuits and its test pattern for combinational logic circuits	Apply
CO2: Analyze testable combinational logic circuits and PLA designs.	Analyze
CO3: Analyze test pattern for sequential circuits and testable sequential logic circuits.	Analyze
CO4: Analyze test patterns and algorithms used in BIST architectures and RAM testing, using appropriate tools and techniques while developing practical verification skills for evolving hardware systems	Analyze

Course Articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	3	-	-	-	-	-	-	2	-	3

High-3; Medium-2;Low-1

Text Books:

T1.Parag K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.

T2. Miron Abramovici, Melvin A.Breuer, Arthur D. Friedman, “Digital systems Testing and Testable Design”,Jaico Publishing House, 2001.

Reference Books:

R1. Alexander Miczo ," Digital Logic Testing and Simulation" Wiley & Sons, 2003.

R2.Angela Krstic and Kwang-Ting Cheng,“Delay fault testing for VLSI Circuits”, Kluwer Academic Publishers, 1998.

Web References:

1. https://www.youtube.com/watch?v=otOSL1ZLnOo

2. https://www.youtube.com/channel/UC3sDCb3ljCe4BODDUjWatWQ/videos?view=0&sort=da

Course Code: 23EAE004		Course Title: Verilog Modeling and Verification	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3 :0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on basic language features of Verilog HDL, modeling digital circuits with various levels of Verilog and analyze the synthesis process of combinational and sequential circuits.

Module I **22 Hours**

Basic Concepts

Design Flow, Importance of HDL, Hierarchical Modeling Concepts, Lexical conventions, Data types, system tasks, Compiler directives, Modules and Ports.

Gate-Level Modeling and Dataflow Modeling

Gate-level Modeling - Verilog gate primitives, and/or and buf/not type gates, rise, fall and turn-off delays, min, max and typical delays. Dataflow modeling - Continuous assignments, expressions, operators, operands, operator types, Modeling Combinational logic circuits.

Module II **23 Hours**

Behavioral Modeling and Advanced Verilog

Structured procedures, blocking and non-blocking statements, event control, loops, sequential and parallel blocks, Tasks and functions, Modeling FSM, Switch Level Modeling, Logic Synthesis with Verilog HDL.

Verification

Test bench, Delays in Assignment statements, Unconnected ports, Missing latches, Event List, Synthesis Directives, Blocking and Non-blocking Assignments.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand language constructs and basic language elements of Verilog HDL.	Understand
CO 2: Model digital circuits using gate –level and dataflow modeling levels of Verilog.	Apply
CO3: Model sequential logic circuits and finite state machine using Verilog.	Apply
CO4: Analyze the synthesis process and functionality of digital systems using test benches.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	2	2	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	-	-	2	-	-	-	-	-	-	1	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Samir Palnitkar,"Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, Second edition, 2003.

T2.Padmanaban, Tripura Sundari, "Design through Verilog HDL, Wiley 2009.

Reference Book(s):

R1. Michael D. Ciletti,"Advanced Digital Design with the Verilog HDL", Pearson Education, Second edition, 2011.

R2.Stephen Brown, Zvonko Vranesic,"Fundamentals of Digital Logic with Verilog Design", Tata McGraw Hill, Second edition, 2007.

Web References:

1. https://www.chipverify.com/tutorials/verilog
2. https://nandland.com/learn-verilog/

Course Code: 23EAE005		Course Title: VLSI for Wireless Communication	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3 : 0 : 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on design of VLSI circuits used in wireless transceivers, low noise amplifiers, mixers, frequency synthesizers and analog to digital converters.

Module I **22 Hours**

Communication Concepts and Receiver Architectures

Access methods, Modulation Schemes, Classical Channel, Wireless Channel Description, Path loss, Multipath fading, Channel Model, Envelope fading, Frequency selective Fading, Fast Fading. Receiver front end, Filter Design.

Low Noise Amplifier and Active Mixer

Wideband LNA Design, Narrow Band LNA: Impedance Matching, Core Amplifier, Gilbert Mixer – Circuit, Low frequency and High frequency Analysis.

Module II **23 Hours**

Passive Mixer and Analog-to-Digital Converters

Double Balanced Switching Mixer, Unbalanced Switching Mixer – Circuit, Distortion, Conversion Gain, Noise, A/D Converter in Receiver, Implementation of Low-Pass Sigma-Delta Modulators and Bandpass Sigma-Delta Modulators.

Frequency Processing Components and Transmitter Architectures

PLL based Frequency Synthesizer, Phase Detector, VCO, LC Oscillators, Ring Oscillators. Loop Filter – First Order, Second Order, High Order Filters, Loop Filter Design. Transmitter Back End, Quadrature LCO Generator.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Design the modules needed for wireless receivers.	Apply
CO 2: Design wireless systems using low noise amplifier and active mixer.	Apply
CO3: Design modules such as passive mixers and ADC converters for wireless transceivers.	Apply
CO4: Analyze different frequency components and modules in transmitter architectures.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	1	-	2
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Bosco Leung,"VLSI for Wireless Communication", Springer, Second Edition, 2011.

T2.David Tsee, Pramod Viswanath," Fundamentals of Wireless Communication", Cambridge Univ Press, 2005.

Reference Book(s):

R1. Emad N Farag, M.I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", KluwerPublication, 2013.

R2. Wen-Chih Kan,"VLSI Architecture for High-capacity Wireless Communications", University of Minnesota, 2007.

Web References:

1. https://nptel.ac.in/courses/117/102/117102062/
2. https://www.maven-silicon.com/blog/vlsi-for-wireless-technology/

SIGNAL PROCESSING ELECTIVES

Course Code: 23ECE025		Course Title: Digital Image and Video Processing (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3:0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on fundamentals of Digital Image Processing, Image transforms, Image processing in spatial and frequency domain, models of Image compression and basics of Video processing and video coding

Module I **23 Hours**

Fundamentals of Image Processing and Transforms: Elements of digital image processing systems, Color image fundamentals - RGB, YUV, HSI models, Image sampling, Quantization, basic relationships between pixels –2D transforms - DFT, DCT and KLT

Image Processing Techniques: Image Enhancement - histogram equalization- smoothing and sharpening filters - Feature extraction: Edge detection- Prewitt, Sobel, Canny- Corner detection – Harris corner – Texture extraction – GLRLM, LBP, Gabor filter – shape detection- SURF,SIFT, HoG features - Transform based feature extraction – Wavelet - Image Restoration: Degradation Model, Inverse Filtering, Least Mean Square Filters

Image segmentation: Detection of discontinuities, edge linking and boundary detection- region-based segmentation.

Module II **22 Hours**

Image Compression: Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding – JPEG standards

Basic steps of Video processing: Analog video, Digital video, Time varying image formation model, Geometric image formation, sampling of video signal – Video segmentation: Temporal segmentation–shot boundary detection, spatial segmentation – motion-based- Optical flow, Pixel based - Region based - Multi resolution motion estimation, Application of motion estimation in video coding - Video object detection and tracking.

Fundamentals of Video coding: Inter-frame redundancy, motion estimation techniques – forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy –Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the given digital image using appropriate transforms and filters.	Apply
CO 2: Select a suitable technique to extract necessary features from the given image and restoring the same.	Analyze
CO 3: Develop a suitable algorithm for given digital image and video compression.	Apply
CO 4: Develop a simple mini-project using suitable simulation tool and demonstrate as a team or individual. (For Internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	3	3	-	-	-	1	-	-	1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, 2nd Edition, Pearson Education 2008

T2. Murat Tekalp , “Digital Video Processing”, Prentice Hall, 2nd edition 2015

Reference Book(s):

R1. Reference Book(s): R1. Dr. Jayaraman, S., Essakirajan, S., and Veerakumar, T., “Digital Image Processing”, Tata McGraw Hill, New Delhi, 2012

R2. David Salomon, “Data Compression – The Complete Reference”, 3rd edition, Springer Verlag New york, 2004.

R3. William K-Pratt, “Digital Image Processing”, 4th edition, John Wiley and Sons, 2007.

R4. Yao Wang, Jorn Ostermann and Ya Qin Zhang, “Video Processing and Communications”, Prentice Hall Publishers, 2002.

R5. Mark S. Nixon and Alberto S. Aguado, “Feature Extraction and Image Processing for Computer Vision”, 3rd Edition, Academic Press, 2012.

Web References:

1. https://nptel.ac.in/courses/117/105/117105079/

Course Code: 23ECE026		**Course Title: Speech and Audio Signal Processing (Common to EA,EC)**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) : 3:0 : 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on basic concepts and algorithms of speech and audio processing and synthesis. It also enables the student to design speech and audio coders.

Module I **23 Hours**

Speech Signal Modelling: Mechanism of speech production – Categorization of speech sounds – Discrete time modeling of speech production: Vocal tract – Radiation - Excitation. The complete model – Human Auditory System

Time And Frequency Domain Methods for Speech Processing: Time domain parameters of speech: Short-time Energy and Average Magnitude, Short-time Average Zero-Crossing Rate – Speech vs. Silence discrimination using Energy and Zero Crossings - Short-Time Fourier Transform – Analysis and Synthesis – Homomorphic Filtering – Cepstrum of voiced and unvoiced – Pitch Detection – Formant Estimation

Speech Signal Representations and Coding

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder.

Module II

22 Hours

Background and Preview: Audio signal recording, analysis and representation techniques, audio measurement, sound intensity, noise signal analysis and characterization, stationary and non-stationary signals, probabilistic signal processing techniques with applications for the audio signal analysis, digital filters for audio enhancement.

Audio Coding: Hours Transparent Audio Coding – Perceptual Masking – Noise Shaping: sub-band analysis, temporal noise shaping – Example coding schemes: MPEG-1 Audio layers I and II, MPEG-1 Audio Layer III (mp3), MPEG-2 AAC.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Define and explain the concept related to speech and audio signals.	Understand
CO 2: Apply the concepts of signal processing to obtain required parameters of the speech and audio signals.	Apply
CO 3: Analyze speech and audio signals in time and frequency domains.	Analyze
CO4: Design various coders for the given specifications.	Apply
CO 5: Develop a simple simulation based mini-project related to speech and audio signals and demonstrate as a team or individual.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	-	-	-	-	1	1		1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Ben Gold, Nelson Morgan and Dan Ellis, “Speech and Audio Signal Processing: Processing and Perception of Speech and Music”, 2nd Edition, John Wiley & Sons, 2011.

T2. R.Rabiner and R.W.Schafer, “Digital Processing of Speech signals”, Pearson Education – India, New Delhi, 2010.

Reference Book(s):

R1. Thomas.F.Quatieri, “Discrete-Time Signal Processing”, Pearson Education - India, New Delhi, 2011.

R2. J.L.Flanagan, “Speech Analysis, Synthesis and Perception”, Springer-Verlag, 1972

R3. Wai C. Chu, “Speech Coding Algorithms – Foundation and Evolution of Standardized Coder”, John Wiley & Sons, 2003.

Web References:

1. https://nptel.ac.in/courses/117105081
2. https://archive.nptel.ac.in/courses/117/105/117105145/
3. https://nptel.ac.in/courses/117105133

Course Code: 23ECE027		Course Title: Wavelets and its applications (Common to EA,EC)	
Course Category: : Major		Course Level: Higher	
L:T:P(Hours/Week) : 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on time-frequency analysis and the limitations of classical Fourier methods. It focuses on continuous and discrete wavelet transforms, multirate signal processing, filter bank design, and real-world applications such as image compression, biomedical signal analysis, and fault detection.

Module I **23 Hours**

Fourier basis and Fourier Transform – failure of Fourier Transform – need for Time-Frequency Analysis – Heisenberg's Uncertainty Principle – Short Time Fourier Transform (STFT) – shortcomings of STFT – need for Wavelets. Wavelet basis – Continuous Time Wavelet Transform (CWT) – need for scaling function – Multi-Resolution Analysis (MRA) – important wavelets: Haar, Mexican Hat, Meyer, Shannon, Daubechies. Decimation and Interpolation in Time domain – Decimation and Interpolation in Frequency domain – Multirate systems for a rational factor.

Module II **22 Hours**

Two-channel filter bank – Perfect Reconstruction (PR) condition – relationship between filter banks and wavelet basis – Discrete Wavelet Transform (DWT) – filter banks for Daubechies wavelet function. Feature extraction using wavelet coefficients – image compression – interference suppression – microcalcification cluster detection – edge detection – faulty bearing signature identification.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply time-frequency and wavelet analysis techniques to process and interpret signals with non-stationary characteristics.	Apply
CO 2: Analyze multirate systems, filter banks, and wavelet bases for their role in signal decomposition and reconstruction.	Analyze

CO 3: Analyze wavelet-based systems by applying DWT and filter banks to identify their role in signal and image processing applications	Analyze
CO 4: Analyze wavelet-based techniques by evaluating their effectiveness in real-world applications such as data compression, fault detection, and biomedical signal diagnostics	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	2	-	-	-	-	-	1	1	-	1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. K.P.Soman , K.I. Ramachandran, N.G. Rasmi,"Insight Into Wavelets: From Theory to Practice" PHI Learning Private Limited, Third Edition, 2010

T2. J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications" United States: Wiley, 2011.

Reference Book(s):

R1. Sidney Burrus C, " An Introduction to Wavelets " Academic press, 2014

R2. Stephane G Mallat, A Wavelet Tour of Signal Processing: The Sparse Way" Academic Press, Third edition, 2008

R3. Rao R M and A S Bopardikar, —Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2000

Web References:

1. https://archive.nptel.ac.in/courses/108/101/108101093/
2. https://archive.nptel.ac.in/courses/103/106/103106114/
3. https://archive.nptel.ac.in/courses/117/101/117101001/

Course Code: 23ECE028		Course Title: Multirate Signal Processing (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basic concepts and fundamentals of multirate signal processing and its applications.

Module I **22 Hours**

Fundamentals of Multirate signal processing: Sampling theorem - sampling at sub nyquist rate – Up sampling, down sampling, interpolation, decimation - Resampling with rational factor - Polyphase decomposition - Multi-stage Interpolation and Decimation systems.

Digital Filter Banks: Digital Filter Banks- DFT Filter Bank-Identities- Polyphase representation. Maximally decimated filter banks: Polyphase representation- Errors in the QMF bank -Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank.

Module II **23 Hours**

M-channel perfect reconstruction filter banks: Uniform band and non-uniform filter bank - tree structured filter bank Errors created by filter bank system- Polyphase representation- perfect reconstruction systems

Perfect reconstruction (PR) filter banks: Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR par unitary QMF Bank- Linear phase PR Filter banks Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks

Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank- Alias cancellation- phase - Phase distortion Closed form expression- Polyphase structure- PR Systems

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Define and explain the concept related to multirate signal processing.	Understand
CO 2: Apply the concepts of signal processing algorithms and techniques to design various filter banks.	Apply
CO 3 : Analyze the characteristics of various filters associated with multirate signal processing.	Analyze

CO 4: Design a suitable filter bank for multirate signal processing for given specifications.	Apply
CO5: Evaluate simulation-based mini-projects for various applications by assessing outcomes and presenting results individually or as a team, with effective communication and commitment to continuous learning	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	-	-	-	-	1	1		1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. P. P. Vaidyanathan, “Multirate systems and filter banks”, Prentice Hall, PTR. 1993.

T2. Fredric J. Harris, “Multirate Signal Processing for Communication Systems”, Prentice Hall, 2004.

Reference Book(s):

R1. Sanjit K. Mitra, “Digital Signal Processing: A computer based approach”, McGraw Hill, 1998.

R2. R. E. Crochiere & L. R. Rabiner, “Multirate Digital Signal Processing”, Prentice Hall, Inc. 1983.

R3. J. G. Proakis & D. G. Manolakis, “Digital Signal Processing: Principles. Algorithms and Applications”, 3rd edition, Prentice Hall India, 1999.

Web References:

1. https://onlinecourses.nptel.ac.in/noc20_ee21/preview
2. https://archive.nptel.ac.in/courses/108/101/108101174/
3. https://onlinecourses.nptel.ac.in/noc24_ee76/preview

Course Code: 23ECE029		Course Title: Biomedical Image and Signal Processing (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basic concepts and analysis of various biomedical signals and images with its applications.

Module I **23 Hours**

Fundamentals of Biomedical Signal Processing: Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials.

Analysis of Biomedical signals: Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation - Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments.

Modelling of Biomedical signals: Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG – Muscle contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.

Module II **22 Hours**

Biomedical image analysis: Computer aided diagnosis – Nature of medical images: X-ray imaging – Tomography – Nuclear medicine imaging – SPECT imaging – Positron imaging tomography – Ultrasonography – Magnetic resonance imaging.

Feature Extraction and Classification: Analysis of shape and texture – Representation of shapes and contours – Shape factors – Models for generation of texture – Statistical analysis of texture – Fractal analysis – Fourier domain analysis of texture – Segmentation and structural analysis of texture. Pattern classification and diagnostic decision – Measures of diagnostic accuracy – Applications: Contrast enhancement of mammograms – Detection of calcifications by region growing – Shape and texture analysis of tumours. Deep Learning for Medical image analysis – 3D Convolutional Neural Networks, Deep Learning for Medical image analysis – Generative models for synthetic data.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Define and explain the concept related to Biomedical Signals and images.	Understand
CO 2: Apply the concepts of various signal and image processing algorithms to analyse the characteristics of biomedical signals and images.	Apply
CO 3: Analyse various features associated with biomedical signals and images using suitable techniques.	Analyze
CO 4: Design various filters for the given specifications to estimate the required performance factors for biomedical system	Apply
CO 5: Develop a simulation based mini-project using suitable components and demonstrate as a team or individual.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	-	-	-	-	1	1		1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Rangayyan, “Biomedical Signal Analysis”, Wiley 2002.

T2. Sinha G. R, Patel, B. C., “Medical Image Processing: Concepts And Applications”, Prentice Hall, 2014.

Reference Book(s):

R1. Sornmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier 2005.

R2. Enderle, “Introduction to Biomedical Engineering,” 2/e, Elsevier, 2005.

R3. D.C. Reddy, “Biomedical Signal Processing: Principles and techniques” , Tata McGraw Hill,New Delhi, 2005.

Web References:

1. https://onlinecourses.nptel.ac.in/noc20_ee41/preview

2.https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/

3.https://www.udemy.com/course/biomedical-signal processing/?kw=Biomedical+ signal&src=sac

4. https://onlinecourses.nptel.ac.in/noc22_bt34/preview

Course Code: 23ECE030		Course Title: Computer Vision (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basic concepts and computation related to image analysis. It will also provide exposure to clustering, classification and deep learning techniques applied in this area.

Module I **23 Hours**

Image Processing Foundations: Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture.

Image Formation and Processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine and Projective. Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Feature Extraction and Feature Segmentation: Feature Extraction -Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space 69 Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation -Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation.

Module II **22 Hours**

3D Vision and Motion: Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion–spline-based motion- optical flow – layered motion.

Applications: Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Virtual Reality and Augmented Reality. In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Define and explain the concepts related to Computer Vision.	Understand
CO 2: Apply the image processing algorithms and techniques to perform various operations for the given image.	Apply
CO3 : Analyze various pattern recognition techniques for the given image	Analyze
CO4: Design various image processing models for the given specifications.	Apply
CO 5: Develop a simulation based mini-project in the field of computer vision and demonstrate as a team or individual.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	-	-	-	-	1	1		1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. E. R. Davies, —Computer & Machine Visionǁ, Fourth Edition, Academic Press, 2012.

T2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

Reference Book(s):

R1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

R2. Simon J. D. Prince, —Computer Vision: Models, Learning, and Inferenceǁ, Cambridge University Press, 2012.

R3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008.

Web References:

1. https://onlinecourses.nptel.ac.in/noc19_cs58/preview
2. https://cs231n.stanford.edu/
3. https://onlinecourses.nptel.ac.in/noc23_ee39/preview

EMBEDDED SYSTEMS AND IoT ELECTIVES

Course Code: 23ECE031		Course Title: Embedded Programming (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on Embedded system and programming approaches with a with a comprehensive understanding on interfacing and embedded applications

Module I **22 Hours**

Introduction to Embedded System: History & need of Embedded System, Basic components of Embedded System, Programming Language Classification of Embedded System, Registers & Memory of AT89C51: Description of RAM, Description of CPU Registers, Functions of SFR

Introduction of Embedded C: Introduction to Embedded C, Difference between C & Embedded C, Programming style, Basic structure of C program, Constants, Variables & Data Types: Keywords & Identifiers, Keywords & Identifiers, Data type & its memory representation, Arrays and strings, Operators: Types of Operators.

Module II **23 Hours**

Control Structures & Loops & Functions: IF statement, If..else statement, Switch statement, and GOTO statement, The While and Do – While statements, For statement,

Functions: Types of Functions, Return values & their types, Introduction To Softwares: Keil, Proteus

Interfacing: LED, Seven Segment Display, LCD, Switches & Keyboard Matrix, Motors, Timer and counter ,ADC, Sensors

Case study: Design applications- Automotive systems, Mobile phones.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply different programming approaches in Embedded C for specific applications.	Apply
CO 2: Analyze the architecture and components of embedded systems, including memory and CPU registers.	Analyze
CO 3: Analyze control structures and functions in Embedded C, assessing their impact on program efficiency and readability.	Analyze
CO 4: Demonstrate the ability to interface various components (LEDs, displays, motors, sensors) with microcontrollers	Apply
CO 5: Effectively work in teams to design and implement an embedded systems project ethically, demonstrating communication and collaboration skills in a technical environment using appropriate tool.(for internal assessments only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	2	-	-	1	3	3	3	3	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Richard H. Barnett, Sarah Cox, Larry O'Cull, "Embedded C Programming and the Atmel AVR", Cengage Learning, 2003

T2.Warwick A. Smith, C Programming for Embedded Microcontrollers. Netherlands, Elektor International Media BV, 2008.

Reference Book(s):

R1. Kai Qian, David Den Haring, Li Cao, "Embedded Software Development With C", Springer Science & Business Media,2009

R2. Michael J. Pont,Embedde C, Pearson Education, 2007.

R3. Prinz, Peter, and Crawford, Tony. C in a Nutshell. United States, O'Reilly Media, 2015.

Web References:

1. https://www.digimat.in/nptel/courses/video/106105193/L06.html

Course Code: 23ECE032		Course Title: Advanced Microprocessor and Microcontroller (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course provides an understanding of Intel 64-bit processors, including memory organization, addressing modes, and multi-core architectures, STM32F0 microcontroller. Students will learn about operand addressing, instruction cycles, and memory management.

Module I **22 Hours**

Intel 64 bit processors-: Overview of 64-bit processor execution environment – Memory organization – IA-32 memory models – Memory organization in 64-bit mode – Extended physical addressing in protected mode - Basic program execution registers – Operand addressing. Multicore Architectures: Concepts – Power reduction techniques in processors.

Module II **23 Hours**

Introduction to STM32 Microcontrollers(STM32F0) - STM32 Architecture - Data Memory Organization in STM32 - Instruction Types and Addressing Modes - Instruction Cycle and Timing - I/O Ports and Peripheral Interfacing - Interrupt Handling in STM32 - Programming STM32 Microcontrollers – DMA, RTOS.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the concepts of execution environment and memory organization to configure and work with Intel 64-bit processors.	Apply
CO2: Implement embedded applications using STM32 microcontrollers and peripheral interfacing techniques.	Apply
CO3: Analyze and compare multicore architectures with respect to performance and power efficiency.	Analyze

CO 4: Involve in team and complete a real time project using advanced processors.(For internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2		-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
C04	-	-	-	-	-	-	-	-	3	-	3	3	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Barry B. Brey, "The Intel Microprocessors: Architecture, Programming, and Interfacing", 8th Edition, Pearson Education, 2009.

T2. David J. Otten, Getting Started with STM32: Developing with the STM32 Nucleo Board, Springer, 2016.

Reference Book(s):

R1. Andrew S. Tanenbaum, "Structured Computer Organization", 6th Edition, Pearson, 2013.

R2. Ravi Soni, STM32 ARM Cortex M3 M4 Programming, Lulu Publishing, 2017.

R3. James L. Antonakos, "The Intel Microprocessor Family: Hardware and Software Principles", Pearson, 2006.

Web References:

1. www.intel.com/content/www/us/en/developer/articles/technical/intel-64-architecture-software-developer-manual-325383.html
2. https://www.st.com/en/microcontrollers-microprocessors/stm32f0-series.html
3. https://en.wikipedia.org/wiki/STM32

Course Code: 23ECE033		Course Title: Embedded Real Time systems (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on embedded system design and embedded programming. Students will learn the fundamental principles, methodologies, and tools required to design, develop, and optimize embedded systems, which include hardware and software integration.

Module I **22 Hours**

Introduction to Embedded system Design: Complex systems and microprocessors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques -Designing with computing platforms – consumer electronics architecture –platform-level performance analysis.

Embedded Programming: Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

Module II **23 Hours**

Real Time Systems: Structure of a Real Time System –– Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

Processes and Operating Systems: Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes - Distributed embedded systems – MPSoCs and shared memory multiprocessors. Case Studies of RTOS: Vx Works, Embedded Linux, Tiny OS and Basic Concepts of Android OS.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Demonstrate responsibility in selecting appropriate design methodologies, quality assurance practices, and power optimization strategies in professional engineering applications.	Apply
CO 2: Conduct performance analysis of embedded systems focusing on computational efficiency, power consumption, and program size.	Analyze
CO 3: Analyze the structure and scheduling of real-time systems	Analyze
CO 4: Analyze the performance and optimization of real-time operating systems (RTOS)	Analyze
CO 5:. Engage in a team and make an oral presentation on the case studies(for internal assessment only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	-	-	-	3	3	-
CO5	-	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher

T2. Jane W.S.Liu, “Real Time Systems”, Pearson Education, Third Indian Reprint, 2003

Reference Book(s):

R1. David. E. Simon, “An Embedded Software Primer”, 1st Edition, Fifth Impression, AddisonWesley Professional, 2007.

R2. K.V.K.K.Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dream Tech Press, 2005

R3. Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, Third Edition Cengage Learning, 2012

R4. Raj Kamal, Embedded Systems Architecture, Programming and Design, 2 nd Ed., McGraw Hill

Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105229/
2. https://www.brainkart.com/subject/Embedded-and-Real-Time-Systems_362/

Course Code: 23ECE034		Course Title: MEMS Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on design of MEMS fundamentals, fabrications and modelling.

Module I **22 Hours**

Definition of MEMS. MEMS devices. Silicon as a MEMS material – mechanical properties of silicon. Mechanical components in MEMS. Design concepts of mechanical components. Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics and heat transfer.

Module II **23 Hours**

Materials for MEMS and Microsystems. Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapor Deposition – Etching. Micro manufacturing – Bulk and surface micro machining – LIGA. Microsystems Design – Design considerations – Process design – Mechanical Design – CAD – Micro system packaging – Levels – Bonding – Interfaces – Assembly – Selection of Packaging Materials.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply scaling principles to design mechanical MEMS components.	Apply
CO 2: Analyze the role of materials and their properties in MEMS system design.	Analyze
CO 3: Differentiate between various MEMS fabrication technologies to determine their suitability for specific applications.	Analyze

CO 4: Examine various packaging and bonding techniques to determine their effectiveness in MEMS system integration.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	3	-

High-3; Medium-2;Low-1

Text Book(s):

T1. TaiRan Hsu, Mems & Microsystems Design and Manufacturing , John Wiley & Sons 2008 2nd Edition

T2. Introduction to Microelectromechanical Systems Engineering by Nadim Maluf and Kirt Williams

Reference Book(s):

R1. "Silicon Micromachining and Fabrication Techniques" by Michael Huff.

R2. "Micro and Smart Devices and Systems" by S. K. Sinha, S. Konishi, and P. S. Ghosh.

R3. "Analysis and Design Principles of MEMS Devices" by Minhang Bao.

R4. "Design and Development of MEMS-Based Guided Weaponry" by Julian W. Gardner

Web References:

1. http://memsnet.org/news/
2. https://eda.sw.siemens.com/en-US/ic/ic-custom/mems-design/mems/
3. https://europractice-ic.com/

Course Code: 23ECE035		Course Title: IoT Based System Design (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to impart solid understanding of Internet of Things (IoT) technologies and their practical applications

Module 1 **23 Hours**

Foundations of IoT:Rise of the machines – Evolution of loT – Web 3.0 view of loT – Definition and characteristics of loT – IoT Enabling Technologies – IoT Architecture — Fog, Edge and Cloud in IoT – Functional blocks of an loT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects -IoT levels and deployment templates – A panaromic view of IoT applications.

Embedded Systems for IoT:Basic architecture of an IoT based Embedded Systems., Embedded Hardware for IoT applications, like Raspberry Pi, Arduino, and ARM development board, IoT Cloud Platform and IoT client applications on mobile phones.

Module 2 **22 Hours**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks.

Application Transport Methods: Supervisory Control and Data Acquisition –Application Layer Protocols: CoAP and MQTT- Data aggregation & dissemination.Home automations – Smart cities – Environment – Energy – Retail – Logistics – Agriculture - Industry– Health and life style – Case study.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Build basic IoT models using key technologies, architecture, and deployment methods for practical applications	Apply
CO2: Examine the architecture and components of embedded IoT systems to assess their suitability for specific applications and cloud integration.	Analyze
CO3: Analyze various IoT access and network layer protocols to determine their effectiveness in supporting constrained devices and low-power networks	Analyze
CO4: Evaluate application layer protocols and data transport methods to determine their suitability for various IoT domains.	Analyze

Course Articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-		-	-
CO2	-	3	-	-	-	-	-	1	-	-	-	1	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	2
CO4	-	-	-	3	-	-	-	-	-	-	-	-	3	-

High-3; Medium-2;Low-1

Text Books:

T1. Honbo Zhou, Internet of Things in the cloud: A middleware perspective, CRC press, 2012.

T2. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-onApproach), VPT, 1st Edition, 2014.

Reference Books:

R1. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press, 2017.

R2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, Internet of Things (IoT) in 5G Mobile Technologies Springer International Publishing Switzerland 2016.

R3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things Springer-Verlag Berlin Heidelberg, 2011.

R4. Muhammad Ali Mazidi,Shujen Chen, Sepehr Naimi,Sarmad Naimi, “Embedded Programming Using C Language”, 1st Edition, Freescale ARM Cortex-M.

R5. Dr. OvidiuVermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publisher

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2. https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Course Code: 23ECE036		Course Title: Industrial IoT and Industry 4.0 (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on IoT Nodes & Sensors, Gateways, Cloud Systems, Cloud Dashboards, Challenges in Iot system Design – Hardware & Software

Module I **22 Hours**

IoT Communication protocols :IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics. UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, ZigBee Interfacing and study of signal flow.

External Interface: IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins. Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors.

Module II **23 Hours**

IoT Solutions for Industry: Configuration of the cloud platform, sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc. Tracking of cloud data as per the requirement; Google Cloud service architect; AWS clod Services architect; Microsoft Azure cloud services Architect; OEN source Cloud Services; Initial State Iot Dashboard & Cloud Services. Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply communication protocols and microcontroller platforms to interface sensors, actuators, and external devices in IoT-based hardware systems	Apply
CO2: Interface peripheral devices with Arduino and Raspberry Pi using Python and standard communication protocols	Apply
CO3: Examine various cloud platform architectures and communication methods to evaluate their effectiveness in IoT.	Analyze
CO 4: Evaluate hardware design factors to ensure reliability and performance in industrial IoT systems	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	-	2

High-3; Medium-2; Low-1

Text Book(s):

T1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547

T2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

Reference Book(s):

R1. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

R2. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

R3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan

Web References

1. https://archive.nptel.ac.in/courses/106/105/106105195/
2. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

Course Code: 23EAE006		Course Title: Embedded Networking and Automation	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on Embedded communication protocols, Ethernet Controllers and Embedded Networking and Automation

Module I **22 Hours**

Embedded Communication Protocols: Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming - ISA/PCI Bus protocols –Firewire

USB and CAN Bus: USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets – Data flow types –Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction - Frames –Bit stuffing – Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface – A simple application with CAN

Module II **23 Hours**

Embedded Ethernet: Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers –Using the internet in local and internet communications – Inside the Internet protocol. Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems

Wireless Embedded Networking and Automation: Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing Data Centric routing.

processor based digital controllers for switching Actuators: Stepper motors, Relays –System automation with multi-channel Instrumentation and interface

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the networking concepts in embedded applications	Apply
CO 2: Analyze the different bus communication protocols used for embedded networking	Analyze
CO 3: Analyze USB and CAN bus protocols to understand their communication processes, error handling, and practical applications, and implement them using PIC18 microcontroller C programs.	Analyze
CO 4 : Build a system automation for different applications	Apply
CO 5: Involve in teams and make an oral presentation on the use of embedded systems in automation (Internal Evaluation)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO4	-	3	-	-	-	-	-	2	2	-	-	3	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Catsoulis, J.Designing Embedded Hardware (2nd ed.), O'Reilly Media, 2005

T2. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, Tony Givargis, John & Wiley Publications, 2002

Reference Book(s):

R1. Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port -Jan Axelson, Penram Publications, 1996.

R2. Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series -Dogan Ibrahim, Elsevier 2008

R3. Embedded Ethernet and Internet Complete - Jan Axelson, Penram publications, 2003.

R4. Networking Wireless Sensors - Bhaskar Krishnamachari , Cambridge press 2005.

Web References:

1. https://www.embedded.com/

2. www.linuxfoundation.org/networking/

3. https://www.automationworld.com/

COMPUTING TECHNOLOGIES ELECTIVES

Course Code: 23ECE037		Course Title: Java Programming (Common to EA,EC,EE)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the principles of Object Oriented Programming using Java. The course intends to provide in-depth knowledge on various concepts of Java programming to develop stand-alone applications.

Module I **23 Hours**

Principles of Object Oriented Programming and Java – Data types – Operators – Control flow.

Classes and Objects – Constructors – Access Specifiers – Static members – Inheritance and types – Method overloading and overriding – Nested and Inner class – Abstract classes and Abstract Methods – Final keyword.

Packages – Interfaces – Exception fundamentals and types – User defined Exceptions – Thread – Creating threads – Synchronization – Inter-thread communication.

Module II **22 Hours**

String Handling – String and String Buffer class and functions – String Tokenizer – Math and Clone functions.

Collections – Collection Interfaces: Set, Queue and List – Collection classes: LinkedList, ArrayList, HashSet and TreeSet – Java I/O classes and interfaces – Streams: DataInput/ OutputStream and Reader/ Writer – File concepts – Reading and Writing Files.

Java Swing – Layout Managers – Event Handling – Swing Components: JLabel, JButton, JTextField, JRadioButton and JTextArea.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply object oriented principles in programming to solve real world problems.	Apply
CO2: Develop lifelong learning ability to provide software solutions for societal issues.	Apply
CO3: Analyze the performance of Java programs and provide optimized sustainable solutions using advanced concepts.	Analyze
CO4: Apply appropriate user interface components for an application.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	2	-	-	-	1	-	-	-	-	-	2	-	-
CO3	-	3	-	-	-	-	1	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Herbert Schildt, “Java the Complete Reference”, 12th Edition, McGraw-Hill Education, December 2022.

Reference Book(s):

R1. Cay. S. Horstmann, “Core Java – Volume 1: Fundamentals”, 12th Edition, Oracle, 2021.

R2. Ken Arnold, James Gosling, David Holmes, Prakash Goteti, “The Java Programming Language”, 3rd Edition, Pearson Education, 2000.

Web References:

1. Oracle, Java tutorials, URL: https://www.oracle.com/java/technologies/
2. NPTEL, Course on Programming in Java, URL: https://archive.nptel.ac.in/courses/106/105/106105191/
3. Core Java Tutorial, URL: https://javabeginnerstutorial.com/core-java-tutorial/

Course Code: 23ECE038		**Course Title: Big Data Analytics and Cloud computing (Common to EA,EC,EE)**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week):3 0:0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on big data and analytics and cloud computing concepts.

Module I **22 Hours**

Fundamentals of Big Data: Database Evolution – Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Big data use cases

Understanding Big Data Storage: High Performance Architecture — HDFS —Map reduce and YARN — Map reduce Programming Model.

NoSQL Data Management for Big Data: NoSQL Databases: Schema less Models – Increasing Flexibility for Data Manipulation– Key Value Stores — Document Stores — Tabular Stores — Object Data Stores — Graph Databases– Hive — Sharding — Hbase.

Classification and Clustering: Decision Trees- Bayes Naïve Classifier- Clustering- K-means- Recommendation System

Module II **23 Hours**

Cloud Computing and Models: Cloud Computing: Cloud Types – Characteristics – Measuring Cloud Value and cloud computing cost- Cloud Architecture: Cloud Computing Stack – Cloud Services: IaaS – PaaS – SaaS – IDaaS –CaaS.

Virtualization and Architecture: Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization–Types of Virtualization: Full Virtualization and Para Virtualization - Types of Clouds.

Cloud Platforms Architecture: Data Center Design and Interconnection of networks - Architectural Design of Compute and Storage Clouds.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply Map reduce programming model to run big data applications	Apply
CO 2: Choose appropriate NoSQL databases for processing large scale data	Apply
CO 3 : Identify the architecture, infrastructure and delivery models of cloud computing	Analyze
CO 4: Apply concepts of cloud virtualization techniques to computing resources for solving real time problems	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
T2. Barrie Sosinsky “Cloud Computing Bible”, Wiley Publishing, 2011

Reference Book(s):

R1. Tom White, “Hadoop: The Definitive Guide”, O"Reilly Publication and Yahoo! Press, 4th Edition, 2015.

R2.Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata McGraw-Hill,2013.

R3. Thomas Erl, Zaigham Mahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Prentice Hall, 2013.

Web References:

1. Hadoop complete reference URL: https://hadoop.apache.org
2. Cloud Computing,https://nptel.ac.in/courses/106105167
3. NPTEL Course content URL: https://onlinecourses.nptel.ac.in/noc20_cs92/

Course Code:23ECE039		Course Title: Cryptocurrency and Blockchain Technologies (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on Cryptocurrency and block chain technologies for various security applications.

Module I **23 Hours**

Blockchain Basics: History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Methods of Decentralization - Blockchain and Full Ecosystem Decentralization – Decentralized Autonomous Organization - Platforms for Decentralization.

Cryptocurrency: digital keys and addresses - transaction: life cycle, data structure, Types, Verification - mining – bitcoin networks – wallets - payments - Alternative coins: Theoretical foundations, Name coin, Zcash.

Module II **22 hours**

Ethereum: Ethereum Network – Components of Ethereum Ecosystem – Ethereum Development tools and frameworks: smart contracts, solidity language.

Web 3 and Hyperledger: Introduction to Web 3: Contract Deployment, POST Requests, Truffle – Hyperledger as a Protocol – Reference architecture – Hyperledger Fabric-Distributed Ledger

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Utilize cryptographic techniques and blockchain fundamentals to secure block creation and validation.	Apply
CO2: Apply the principles of cryptocurrency, exemplified by Bitcoin, to propose solutions for real-world challenges.	Apply
CO3: Analyze smart contracts using Solidity and Ethereum tools to interact with ecosystem components.	Analyze
CO4: Design real world application using Hyperledger technologies adhering ethical standards.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2; Low-1

Text book(s):

T1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, 2nd Edition, Packt Publishing, 2018.

Reference Book(s)

R1. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016.

R2. E. Golden Julie, J. Jesu Vedha Nayahi, and Noor Zaman Jhanjhi ,” Blockchain Technology : Fundamentals, Applications, and Case Studies”, CRC Press, 2021.

R3. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.

Web References:

1. https://archive.nptel.ac.in/courses/106/104/106104220/
2. https://www.udemy.com/course/build-your-blockchain-az/
3. https://www.ibm.com/topics/blockchain

Passed in 4th Board of Studies Meeting held on 09.05.2025
Approved in 20th Academic Council Meeting held on 04.07.2025

BOS Chairman

Course Code: 23ECE040		Course Title: Neural Networks and Deep Learning (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to impart knowledge on Neural networks and Deep Learning by equipping students with the ability to implement Neural Network and deep learning models and apply them to solve complex real-world problems.

Module I **22 Hours**

Neural Networks: Biological neural networks – Artificial neurons – Applications.

Supervised Learning Networks: Activation functions, Learning rules, Perceptron networks, Adaline, Madaline, Back propagation networks

Unsupervised Learning Networks: Neural network based on competition – Maxnet – Hamming network – Self-Organizing feature maps – Learning vector quantization

Module II **23 Hours**

Deep Networks: Fundamentals-Architectural Principles of Deep Networks-Building Blocks of Deep Networks.

Convolutional Neural Networks: Convolutions, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, LeNet-**Region-Based CNNs:** R-CNN, Fast R-CNN, Faster R-CNN, Mask RCNN.

Recurrent neural network: Working with Sequences, Converting Raw Text into Sequence Data, Language Models, RNN Implementation, LSTM, GRU, Deep RNN.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Construct feed forward neural networks using supervised learning for solving classification problems.	Apply
CO2: Build unsupervised learning networks using competitive strategy for solving clustering problems	Apply
CO3: Analyze the performance of various CNN models in solving real-world challenges.	Analyze
CO4: Analyze the effectiveness of implementing RNNs for text sequence processing using LSTM and GRU.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	**-**	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, “Dive into Deep Learning”, Cambridge University Press, 2023.

T2. S. N. Sivanandam, S. N. Deepa, “Principles of Soft Computing”, 3rd Edition, John Wiley &

Sons, New Delhi, 2019.

Reference Book(s)

R1. Josh Patterson, “Deep Learning: A Practitioner's Approach”, O'Reilly Media, 2017.

R2. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

R3. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2017.

Web References:

1. https://nptel.ac.in/courses/106/106/106106184/
2. https://in.mathworks.com/discovery/deep-learning.html
3. https://www.kaggle.com/code/kanncaa1/deep-learning-tutorial-for-beginners

Course Code: 23ECE041		Course Title: Augmented Reality and Virtual Reality (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0 :0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the fundamentals of Extended Reality (XR), including the core concepts and technologies of Virtual Reality (VR) and Augmented Reality (AR).

Module I **22 Hours**

Introduction – XR Spectrum – Definitions - Augmented Reality – Virtual Reality – Mixed Reality – History – Challenges – XR and Business

VR IO, Modeling: VR Definition, Input Devices: Trackers, Navigation and Gesture Interfaces, Output Devices: Graphics, Three Dimensional Sound and Haptic Displays, Computer Architecture for VR, Modeling.

VR Application Development: Enabling VR Environment, Building: Steam VR, Oculus Rift, Windows Gear VR, Oculus Go, Google VR, Setting up for Android Devices - 3D walkthrough, Object Grabbing, Transformation, Hand Avatar manipulation, World space menu creation.

Module II **23 Hours**

AR Principles: AR Definition, Displays: Multimodal Displays, Spatial Display Model, Visual Displays, Tracking, Calibration and Registration - Mobile Sensors - Computer Vision for AR.

AR Application Development: Mobile Application for Image Tracking, Image Dataset Generation, Setting up AR Environment, Animation and transformation (Scale, Move, Rotate, Transform), Build Generation for iOS and Android. Case Study: Picture Puzzle.

Applications : Retail, Training, Education, Healthcare, Entertainment, Sports, Manufacturing, Military.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply input/output device functionalities and VR modeling concepts to design and develop interactive virtual reality applications.	Apply
CO 2: Analyze the architecture and tools used in VR platforms such as Oculus, SteamVR, and Google VR to develop immersive XR experiences.	Analyze
CO 3: Apply AR tracking, calibration, and mobile sensor techniques to build augmented reality applications for iOS and Android platforms.	Apply
CO 4: Analyze real-world applications of AR and XR technologies across domains like retail, healthcare, education, and military to evaluate their impact and potential.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Berbard Marr, "Extended Reality in Practice", Wiley, 2021.

T2. Jesse Glover, Jonathan Linowes, "Complete Virtual Reality and Augmented Reality Development with Unity", Packt Publishing Ltd, 2019.

Reference Book(s):

R1. Steve Aukstakalnis, “Practical Augmented Reality: A Guide to the Technology Applications, and Human Factors for AR and VR”, Addison-Wesley, 2016. R2.

R2. Robert Scoble, Shel Israel, “The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything”, Patrick Brewster Press, 2016.

Web References:

1. https://developers.google.com/vr/
2. https://developers.google.com/ar/develop/unreal/quickstart
3. https://developers.google.com/ar/develop/unity/quickstart-android

Course Code: 23ECE042		Course Title: Web Programming (Common to EA,EC)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3: 0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The is intended to impart knowledge for designing, validating, and enhancing web pages using HTML5, CSS, and JavaScript. The course also intends to provide exposure to responsive design using Bootstrap framework.

Module I **23 Hours**

HTML5: Introduction – Structure of HTML Documents – Basic HTML Elements – Heading – Paragraph – Images – Line Break and Horizontal Rule – Blockquote – Phrase – Lists – HTML Syntax validation – Structural Elements - Anchor Element – Tables – Forms: Introduction – Form control elements – Table and Form Accessibility – Internal linking – Meta elements – New HTML5 Form input Types – Input and datalist elements and auto complete attribute.

CSS3: Inline, embedded and external style sheets – Positioning Elements – Selectors – Backgrounds – Element Dimension – Box Model and Text flow – Media Types and Media Queries – Drop-Down Menu – Text Shadows – Rounded Corners – Color – Box Shadows.

Module II **22 Hours**

Java Script: Introduction – Data types and Variables - Control Statements - Operators - Literals - Functions - Objects - Arrays - Built in objects - JavaScript Event Handling - Form processing with focus, blur, submit, reset - Event Bubbling - Document Object Model - The Document Tree - DOM Collections – Dynamic Style - Using Timer and Dynamic Styles to Create Animated Effects.

Bootstrap: Containers – Grid System – Display Widths – Advanced Grid Techniques: Row Columns – Vertical Alignment – Horizontal Alignment – Nesting – Collapse and Expand – Navigation Bar– Buttons – Tables – Labels and Badges – Tabs – Alerts – Progress Bar – Cards – Carousels.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Design and structure web page using HTML.	Apply
CO2: Apply CSS styling techniques to enhance the visual presentation of the webpage.	Apply
CO 3: Develop client-side interactivity using Java script.	Apply
CO 4: Design responsive web pages using Bootstrap.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Terry Ann Felke-Morris, Ed.D.,“Basics of web design: HTML5 & CSS”, Pearson, 6th Edition, 2021.

T2.Harvey Deitel, Paul Deitel, Abbey Deitel “Internet and World Wide Web How To Program”, 5th Edition, Pearson Education Asia, 2019.

Reference Book(s):

R1.Panos Matsinopoulos, "Practical Bootstrap: Learn to Develop Responsively with One of the Most Popular CSS Frameworks", APress, 2020.

R2. Randy Connolly and Ricardo Hoar, Fundamentals of Web Development, Pearson, New 8th Edition, 2024.

Web References:

1.HTML: https://www.w3schools.com/html/html5_intro.asp

2.CSS:https://www.w3schools.com/css/

3.Javascript:https://www.javascript.com/

Course Code: 23AME037		Course Title: Computational Quantum Mechanics (Common to AM,EA,EC)	
Course Category: Major		Course Level: Higher	
L: T: P(Periods/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to introduce the concepts of classical and quantum computing to make students to gain knowledge on hardware and mathematical models needed for quantum computation. To teach the basics of quantum information theory and quantum cryptography.

Module I **24 Periods**

Quantum Computing Basic Concepts: Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – Quantum Bits - Representations of Qubits – Superpositions.

Quantum Gates and Circuits: Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development - Quantum error correction.

Quantum Algorithms: Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm.

Module II **21 Periods**

Quantum Information Theory: Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels.

Quantum Cryptography: Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the mathematical principles of linear algebra and complex numbers used in representing quantum states and operators.	Understand
CO 2: Apply the fundamental principles of quantum mechanics to analyze the behavior of qubits and quantum systems.	Apply
CO 3: Construct quantum circuits using appropriate single and multi-qubit gates to perform quantum operations.	Apply
CO 4: Apply quantum algorithms and cryptographic protocols to solve basic problems in computation and secure communication.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	1
CO3	2	-	2	-	-	-	-	-	-	-	-	-	2	1
CO4	2	-	-	-	-	-	-	-	-	-	-	-	2	1

High-3; Medium-2; Low-1

Text Book(s):

T1. Parag K Lala, Mc Graw Hill Education, “Quantum Computing, A Beginners Introduction”, 1st Edition, 2020.

T2. Michael A. Nielsen, Issac L. Chuang, “Quantum Computation and Quantum Information”,10th Edition, Cambridge University Press, 2010.

Reference Book(s):

R1. Chris Bernhardt, “Quantum Computing for Everyone”, The MIT Press; Reprint edition 2020.

R2. Scott Aaronson, “Quantum Computing Since Democritus”, Cambridge University Press,2013.

Web References:

1. https://nptel.ac.in/courses/106106232

Course Code: 23EAE007		Course Title: Machine Learning	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The objective of this course is to equip students with foundational knowledge and practical skills to design, implement, and evaluate machine learning models for real-world applications.

Module I **22 Hours**

INTRODUCTION: Introduction to Machine Learning - Types of Machine Learning systems - Challenges in Machine Learning - Overfitting and Under fitting - Testing and Validating the model - Bias and Variance

MACHINE LEARNING FRAMEWORK: Problem Formulation - Get the data - analyze and visualize the data - Prepare the data for ML algorithms - sample complexity - Hypothesis space - Model evaluation and Improvement: Cross validation - Grid search - Evaluation Metrics - Kernel functions

SUPERVISED LEARNING: Linear and Logistic Regression - Eigen Values and Eigen vectors - Naive Bayes Classifier: Maximum Likelihood, Minimum Description Length - Gradient Descent - Decision Trees - Ensembles of Decision Trees - Support Vector Machine(SVM)

Module II **23 Hours**

UNSUPERVISED LEARNING: Clustering: k-Means clustering- Agglomerative Clustering - DBSCAN- Gaussian Mixtures-precision and recall - Collaborative filtering and Content Filtering-Dimensionality Reduction

NEURAL NETWORK AND DEEP LEARNING: Biological Neuron - Logical computation with Neuron - Perceptron - Sigmoid and softmax functions - Multi Layer Perceptron(MLP) with Back propagation - Regression MLPs - Classification MLPs - Fine Tuning NN models - Convolutional Neural Network: Architecture of Visual cortex - Convolutional Layers - Stacking Multiple Feature Maps-CNN architectures.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze machine learning paradigms and evaluate the suitability of algorithms for various real-world problems.	Analyze
CO 2: Apply data preprocessing, visualization, and feature engineering techniques to prepare datasets for machine learning models.	Apply
CO 3: Implement supervised and unsupervised learning algorithms to solve classification, regression, and clustering tasks.	Apply
CO 4: Analyze the performance of neural network models and optimize deep learning architectures for improved accuracy.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	--	-	-
CO4	-	-	-	2	-	-	-	-	3	-	-	1	3	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow*, 2nd Edition, O'Reilly* Media, 2019.

T2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly Media, 2016.*

Reference Book(s):

R1. Ethem Alpaydin, Introduction to Machine Learning, 3rd Edition, MIT Press, 2014.

R2. Tom M. Mitchell, Machine Learning, McGraw Hill, 1997.

R3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective*, MIT Press, 2012*

Web References:

1. https://scikit-learn.org/stable/
2. https://www.tensorflow.org/
3. https://www.coursera.org/learn/machine-learning

DIVERSIFIED ELECTIVES

Course Code: 23ECE051		Course Title: Computer Architecture (Common to EA,EC,EV)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on memory organization, addressing modes of a processor, the organization of cache memory and pipelining techniques for the design of high speed processor.

Module I Processor Architecture **22 Hours**

Basic Structure of Computers:

Evolution of Microprocessor - Basic Processor Architecture - Operational concepts – Performance.

Instruction Set Architecture:

Memory location - Memory Operations – Instructions and sequencing - Addressing modes - CISC Vs RISC.

Basic Input/Output, Processing Unit :

Accessing I/O devices - Interrupts -Buses - Instruction Execution-DMA–Hardware Components – Instruction Fetch and Execution Steps – Control Signals-Hardwired Control - CISC Style Processors: Interconnect using Buses, Micro programmed Control.

Module II Cache Design and Pipelining **23 Hours**

The Memory System: Characteristics of Memory Systems - Cache Memory Principles - Elements of Cache Design - Mapping Function - Example of Mapping Techniques - Replacement Algorithms - Performance Consideration.

Pipelining : Basic concept - Pipeline Organization and issues - Data Dependencies – Memory Delays – Branch Delays – Resource Limitations - Performance Evaluation - Superscalar operation –Pipelining in CISC Processors - Instruction Level Parallelism – Parallel Processing Challenges – Flynn’s Classification – Hardware multithreading – Multicore Processors: GPU, Multiprocessor Network Topologies.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the features of different instruction set architectures to evaluate their effect on system performance in real-world scenarios.	Apply
CO 2: Analyze various design elements to determine suitable memory organization for optimized performance.	Analyze
CO 3: Examine the principles of pipelining and instruction-level parallelism to understand their impact on processor performance.	Analyze
CO 4: Independently learn about emerging computer architectures and deliver an oral presentation highlighting their impact on society and their contribution to sustainable and environmentally friendly technologies.(For Internal Assessment only)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-		-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	-	-	-	2	2	-	1	1	-	2	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Carl Hamacher, Zvonok Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization and Embedded Systems”, 6th Edition, McGraw Hill, 2012

T2. David A. Patterson and John L. Hennessey, “Computer Organization and Design: The Hardware/Software Interface”, 5th Edition, Morgan Kauffman / Elsevier, 2014

Reference Book(s):

R1. William Stallings, “Computer Organization and Architecture: Designing for Performance”, 10th Edition, Pearson Education, 2016

R2. John L. Hennessey and David A. Patterson, “Computer Architecture: A Quantitative Approach”, Morgan Kauffman / Elsevier, 5th edition, 2012

Web References:

1. https://www.coursera.org/lecture/comparch/course-introduction-Ouq7L
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-823-computer-system-architecture-fall-2005/index.html
3. http://www.nptel.ac.in/courses/106102062/

Course Code: 23ECE052		**Course Title: Linux Programming and Shell Scripting (Common to EA,EC)**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 2:0:2	**Credits:3**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge to demonstrate the ability to work effectively in a Linux environment by applying shell scripting, system programming, and basic networking concepts to develop efficient, process-aware, and concurrent software solutions.

Module I Linux Essentials and Shell Scripting 22 Hours

Operating System – Kernel – Unix – Linux – Advantages – Linux bash – Linux distributions & use cases – Linux Filesystem – Linux Shell – Linux terminal – Command-line basics – File and Directory Operations – GUI based text editors: gedit, GNU Nano, vim – Process management: ps, kill, top, bg – File compression & archiving – Pipes and filters – Input/Output redirection and quoting – Shell Scripting: Script structure and execution – Conditionals – Loops

Module II Linux System Programming, IPC, and Basic Threads 23 Hours

File I/O in C using system calls: open, read, write, lseek, close – File metadata: stat, fstat – Process creation and control: fork(), exec(), wait(), waitpid(), exit(), getpid(), getppid() – Inter-process communication (IPC): unnamed pipes – shared memory – semaphores – message queue basics – Basic POSIX Threads (Pthreads): thread creation and termination using pthread_create(), pthread_join() – Mutexes and synchronization – Race conditions and thread safety concepts - Basic Socket programming for TCP/IP communication

List of Experiments: **30 Hours**

1. Linux command-line tool management
2. Shell Scripting – Loops and Conditionals
3. Shell Scripting – File and Process Management
4. Process Creation and Control
5. Inter-Process Communication (IPC) – Pipes and Shared Memory
6. POSIX Threads and Basic Socket Programming
7. File Operations in C using System Calls

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Demonstrate proficiency in navigating the Linux using command-line tools and basic directory, and process management with the help of shell scripting	Apply
CO 2: Develop C programs using Linux system calls, IPC mechanisms, basic socket programming and POSIX threads to process management	Analyze
CO 3: Apply shell scripting constructs including loops and conditionals for file and process automation tasks in Linux	Apply
CO 4: Analyze inter-process communication and synchronization mechanisms using pipes, shared memory, semaphores, and threads	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Richard Blum, *"**Linux Command Line and Shell Scripting Bible**"*, Wiley

T2. W.Richard Stevens, *"**Advanced Programming in the UNIX Environment**"*, Addison-Wesley

T3. M.G. Venkateshmurthy, "***Introduction to UNIX and Shell Programming"***, Pearson

Reference Book(s):

R1. Ganesh Sanjiv Naik, ***"Learning Linux Shell Scripting"***

R2. Shantanu Tushar Sarath Lakshman, ***"Linux Shell Scripting Cookbook"***, Second edition

Web References:

1. https://www.geeksforgeeks.org/linux-tutorial/

2.https://www.w3schools.in/operating-system/linux-operating-system

Course Code: 23EEE014		Course Title: Industrial Automation (Common to EA,EC,EE,EV)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to cutting-edge technologies such as Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA), and Distributed Control Systems (DCS), students will learn to develop innovative automation solutions. The course emphasizes hands-on experience in designing control logic programs, configuring industrial networks, and exploring real-world applications.

Module I **22 Hours**

Introduction to Factory Automation: History and developments in industrial automation- Vertical integration of industrial automation- Building blocks in Automation: Processing systems, Multi microprocessor systems, LAN, analog and digital I/O modules, remote terminal unit

Programmable Logic Controllers :PLC an Overview- Parts and Architecture of PLC- Principles of Operation - I /O Specifications - Memory types-Programming devices- PLC vs Computers, PLC size and Applications, Advantages of PLC, selection of PLC

Programming of PLC : Program scan - PLC Programming Languages-Simple process control programs using Relay Ladder Logic - Programming Timers : On delay timer, OFF delay timer- Programming counters: Up and Down counter – PLC arithmetic functions – Program Control Instructions-Math Instructions-data transfer operations-Data comparison

Module II **23 Hours**

Industry Networking and SCADA :PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet .SCADA-Channel scanning-conversion to engineering units- data processing –Distributed SCADA systems- HMI introduction

Distributed Control System and Applications : DCS: Evolution – Different architectures – local control unit – Operator interface – Displays – Engineering interface. Applications: Thermal power plant-cement plant-water treatment plant- Solar, windmill substation automation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the principles of automation to identify its necessity in industrial processes.	Apply
CO 2: Analyze the architecture and types of PLCs used in industrial automation to select suitable options.	Analyze
CO 3 : Develop PLC-based control logic programs to meet specific industrial requirements.	Apply
CO 4: Analyze industrial networking protocols and SCADA systems to implement effective automation.	Analyze
CO 5: Apply the concepts of DCS to evaluate its applications in power plants and other industrial setups.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Frank D Petruzella “Programmable Logic Controllers", McGraw Hill Education India Private Limited, 6th Edition, 2023.

T2. Bolton.W, “Mechatronics”, Pearson Education, Delhi, 7th Edition,2018.

Reference Book(s):

R1. John W Webb & Ronald A Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, 5th edition, 2011

R2. Dobrivojie Popovic, Vijay P. Bhatkar,“ Distributed Computer Control for Industrial Automation”, Marcel Dekkar Inc., New York, 1st edition, 2011.

R3. Krishna Kant, „Computer based Industrial Control", Prentice Hall of India, 2nd edition, 2010

R4. Rajesh Mehra and Vikrant Vij, “PLCs& SCADA- Theory and Practice”, Laxmi Publications, 1st edition, 2019.

Web References:

1.http://www.fieldbus.org

2.www.nptel.ac.in/downloads/108105063/

3.http://nptel.ac.in/courses/108105062/18

Course Code: 23EEE085		Course Title: Automotive Electronics (Common to EA,EC,EE,EV)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The learners will be able to develop foundational knowledge of mechanical and electronic systems in modern automobiles. Additionally, the course focus on the role and implementation of embedded systems and X-by-wire technologies in automotive applications.

Module I **22 Hours**

Automotive Mechanical Systems: Overview of vehicle systems including the powertrain (air, fuel, ignition, exhaust and cooling), transmission types, braking systems, and steering mechanisms.

Electronics in Automotive Systems: Role of electronics in enhancing performance, control and compliance with legislation. Introduction to chassis subsystems (ABS, TCS, ESP), and comfort/safety features (airbags, seatbelt tensioners, cruise control).

Module II **23 Hours**

Drive-By-Wire Technologies: X-by-wire technologies: Steer-by-wire, brake-by-wire, shift-by-wire, and future trends.

Embedded Systems and EV Introduction: Sensor and actuator systems in gasoline/diesel engines (NOx, knock, MAP, oxygen, throttle position), thermal actuators, and body electronics (central locking, climate control). Introduction to electric vehicle classifications.

Vehicle Communication Protocols: Overview of SPI, I2C and automotive-specific protocols including CAN, LIN and MOST. Introduction to AUTOSAR framework for standardization and Ethernet.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify the key components and functions of automotive mechanical systems such as powertrain, transmission, braking, and steering, safety, and compliance.	Apply
CO2: Apply the role of electronic systems in enhancing vehicle performance, safety features, and regulatory compliance.	Apply
CO3: Examine the working principles of X-by-wire technologies and apply knowledge of sensors and actuators in automotive embedded system design.	Apply
CO4: Apply standard in-vehicle communication protocols to develop basic automotive communication systems and demonstrate the use of AUTOSAR for system integration.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	1	1	-	-	1	-

High-3; Medium-2;Low-1

Textbooks:

T1. Robert Bosch GmbH, "Bosch Automotive Handbook", 10th Edition, Wiley Publishers, 2019.

T2. William B. Ribbens, “Understanding Automotive Electronics”, 7th Edition, SAMS/Elsevier

Reference Book(s):

R1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, 5th edition, Springer Vieweg, Wiesbaden 2014

R2. Knowles.D, Automotive Electronic and Computer Controlled Ignition Systems, Reston Pub Co,1990 R3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

R3. JoergSchaeuffele, Thomas Zurawka – Automotive Software Engineering – Principles, Processes, Methods and Tools, SAE, 2016

Web References:

1. www.austincc.edu/autotech
2. https://acconline.austincc.edu/webapps/portal/frameset.jsp

Course Code:23MEE008		Course Title: PLM for Engineers (Common to all B.E/B.Tech Programmes)	
Course Category: Minor		Course Level: Higher	
L:T:P (Hours/Week): 2: 0: 2	Credits: 3	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to apply Product Lifecycle Management (PLM) fundamentals and principles to develop strategies, manage product lifecycles, optimize engineering processes, configure Bills of Materials, and leverage digital manufacturing environments for practical applications and customer-centric use cases.

Module I **22 Hours**

Business Strategy in the PLM

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment.

Business Processes in the PLM and Product Development Concepts

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM. Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM

Module II **23 Hours**

Digital Mock Up and Validation

Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral

Digital Manufacturing in the PLM

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

Customer Use Cases of the PLM

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, Sunseeker International , Xtrac ,kesslers international and monier and weatherford international.

List of Exercises: **15 Hours**

1. Demonstrate the 2-Tier & 4-Tier Architectures and Basic Team center applications like Organization, Project, and Schedule Manager.
2. Create CAD and Non-CAD datasets (MS Office, Notepad, etc.) by using explicit and implicit Check-In and Check-Out to create multiple iterations
3. Create the access control (Read, Write, and Delete) for the given dataset and block the access rights to other group members belongs to the same department. Also Perform the Impact Analysis (Where Used and Where Referenced) of a given dataset which is used in multiple assemblies.
4. Create the Product Structure in Structure Manager with 5 components assembled in first level and 3 components Assembled in second, third and fourth level with the sub-assemblies and export the assembly in local drive. Also, demonstrate the Variant Management.
5. Export the CAD dataset as a JT file and perform the various visualization tasks like Measurements, Sectioning, PMI, and Mark-up using JT2GO application

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the fundamentals of PLM principles to develop a PLM strategy for a system.	Apply
CO2: Apply PLM principles to manage product lifecycles, optimize engineering processes, and configure Bill of Materials with consistent workflows	Apply
CO3: Apply the Digital Manufacturing environment using PLM for use cases.	Apply
CO4: Develop and present a report individually by applying various modules of PLM software for an engineering project.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	3	-	-	-	-	-	1	1	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. John Stark, “Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation”, Springer International Publishing Switzerland, 4th Edition, 2020.

T2. Grieves Michael, “Product Lifecycle Management- Driving the Next Generation of Lean Thinking”, McGraw-Hill, 2010.

T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

. **Reference(s):**

R1. Elangovan, U., “Product Lifecycle Management (PLM)”. Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. Antti Saaksvuori, “ Product Life Cycle Management” - Anselmi Immonen, Springer, 3rd Edition, 2008.

Course Code:23MEE030		Course Title: Principles of Management (Common to EA,EC,EE,EV,ME)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course is intended to study the role of managers, the significance of planning, decision-making, and strategies in international business, the importance of organizing tasks, various motivational theories, and control techniques.

Module I **22 Hours**

OVERVIEW OF MANAGEMENT :

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business

PLANNING:

Nature and Purpose planning – Planning process – Types of Plans – Objectives – Managing by Objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision – Decision Making Process – Rational Decision Making Process – Decision Making under different Conditions.

ORGANISING:

Nature and purpose of organizing – Organization structure – Formal and informal groups organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recuritment – Orientation Career Development – Career stages – Training – Performance appraisal.

Module II **23 Hours**

DIRECTING :

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – organization culture – elements and types of culture – managing cultural diversity.

CONTROLLING:

Process of controlling – types of control – budgetary and non – budgetary control techniques – managing productivity – cost control – purchase control – maintenance control – quality control – planning operations.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply management principles to understand the roles and functions of managers in various organizational and business contexts.	Apply
CO 2: Develop and implement effective planning, decision-making, and strategic management practices to achieve organizational objectives in both domestic and international settings.	Apply
CO 3 : Prepare and present a seminar individually on organizational, motivational and control techniques including task allocation, employee engagement strategies, budgeting, and quality management to enhance productivity and efficiency.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. hen P. Robbins, Rolf Bergman and Mary Coulter, “Management”, Prentice Hall of India, 8th edition, 2017.

T2. Charles W.L Hill, Steven L McShane, “Principles of Management”, Mcgraw Hill Education, 2008

Reference Book(s):

R1. Hellriegel, Slocum & Jackson, “Management – A Competency Based Approach”, Thomson South Western, 10th edition, 2007.

R2. Harold Koontz, Heinz Weihrich and mark V Cannice, “Management – A global & Entrepreneurial Perspective”, Tata McGraw Hill, 12th edition, 2007.

R3. Andrew J. Dubrin, “Essentials of Management”, Thomson Southwestern, 7th edition, 2007

Course Code: 23AUE051	Course Title: Design Thinking and Innovation (Common to all B.E/B.Tech Praogrammes)		
Course Category: Major		Course Level: Higher	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to equip learners with practical skills in design thinking, empathy, prototyping, testing, and implementation for user-centered innovation and effective product development.

Module I **(17+ 6 hrs)**

Introduction- Importance of Design Thinking, Human Centered Design, Six-Step Design Thinking Process-Framework for Innovation-DT-a nonlinear process.

Empathy-importance of empathy in design thinking- empathy vs sympathy- steps of empathize-understanding customer needs-empathy methods and tools-empathy map-5W 1H framework-empathize in UX/UI Design-users Interview

Module II **(18+4 hrs)**

Prototype: Introduction to Proof of concept-MVP-Prototype and its types-prototype methodology- innovation and its types-Tools for prototyping: concept sketching/CAD/3D Printing.

Testing: Importance of testing in product development-design validation-market analysis: TAM-SAM-SOM-EVG.

Implementation - redesign of solution and iterative process.

List of activities

Core Stream

Empathy

1. What challenges does the user face daily commuting to work place?

2. What are the user's biggest frustrations when interacting with vehicle maintenance engineer?

3. Understand the user for building old age home.

Define

1. A construction site supervisor needs better real-time communication tools because delayed updates cause safety risks. (Provide the empathy data)

2. "Drivers get confused by inconsistent road signs," create: "How might we improve road sign clarity to reduce driver confusion?"

3. A daily commuter needs a safer way to cross busy intersections because current pedestrian signals are confusing and slow. (Provide the empathy data)

Ideate

1. Develop a creativity safer vehicle dashboard design

2. Develop an improved road drainage system

3. Design an innovative solution to reduce urban flooding caused by heavy rains.

4. Design a Hybrid engine designs incorporating solar panels on the car roof.

Prototype

1. Prototype development (both low fidelity and high fidelity) on any real world problem

IT and Circuit Stream:

Activity 1:

Students role-play as designers and users- create an empathy map with 4 quadrants: *Says, Thinks, Does, Feels*

Circuit Stream- Empathy Interview and Persona Creation

Define- development of problem Statement-Elements of a Good Problem Statement-Tools: Point-of-View (POV) Statements-How Might We (HMW) Questions-User Personas.

Ideation in Design Thinking-Importance of Ideation-Metrics of ideation -tools: Brainstorming-Mind Mapping-SWOT.

Activity 2:

IT Stream- SWOT analysis on software project idea.

Circuit Stream -Idea Pitch Canvas using Brainstorming + Mind Mapping

Convert ideas into quick prototypes and validate through early testing.

Activity 3:

IT Stream -Build a simple algorithm to test feasibility- TAM-SAM-SOM market analysis chart

Circuit Stream -MVP Canvas and Concept Sketching

Circuit Stream -Iterative Redesign and Peer Testing Sprint

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply design thinking tools like empathy mapping, problem definition, and ideation to create user-centered innovative solutions.	Apply
CO2: Apply prototyping, innovation, testing, and iterative redesign techniques in product development and market analysis..	Apply
CO3: Apply design thinking to develop, prototype, and validate innovative engineering solutions in capstone projects for real-world applications.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	-	-	-	2			2	2	2	2	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Sabell Osann, Lena Mayer , Inga Wiele ,The Design Thinking Quick Start Guide: A 6-Step Process

for Generating and Implementing Creative Solutions, Wiley, 2020.

T2. Christian Müller-Roterberg, Handbook of Design Thinking, Kindle Direct Publishing,2018.

Reference Book(s):

R1. Teun den Dekker, Design Thinking, Taylor & Francis, International edition, 2020.

R2. Kaushik Kumar, Divya Zindani, J.Paulo Davim, Design Thinking to Digital Thinking, Springer, 2019.

R3.S. Balaram, Thinking Design, SAGE Publications, 2011.

Course Code: 23SCE050		Course Title: Cyber security (Common to AD,AM,AU,CE,EA,EC,EE,EV,ME)	
Course Category: Minor		Course Level: Higher	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives: To provide foundational knowledge of cyberspace, cyber laws, and digital security practices to identify, prevent, and respond to cyber threats.

Module I: **22 Hours**

Introduction to Cyber Security: Defining Cyberspace - Overview of Computer and Web-technology - Architecture of cyberspace, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Cyber-crime and Cyber law: Classification of cyber-crimes - cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organizations dealing with Cyber-crime and Cyber security in India, Case studies

Module II: **23 Hours**

Social media and Security: Introduction to Social networks, Social media – Types, platforms, monitoring, Hashtag, Viral content, marketing, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

E-Commerce and Digital Payments: E- Commerce - Definition, Components, Security, Threats, Best practices - Digital payments – Components, stake holders, Modes of digital payments - Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act,2007.

Digital Devices Security, Tools and Technologies for Cyber Security: End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions

Case studies and Assignments:

1. Prepare checklist for following scenarios :
   a) Reporting cybercrime at Cybercrime Police Station.
   b) Reporting cybercrime online.
   c) Using popular social media platforms.
   d) Secure net banking.
2. Demonstrate the following:
   a) Reporting phishing emails, email phishing attack and preventive measures.
   b) Reporting and redressal mechanism for violations and misuse of Social mediaplatforms.
3. Manage the following activities:
   a) Privacy and security settings for popular Social media platforms, Mobile Walletsand UPIs.
   b) Application permissions in mobile phone.
4. Perform the following activities:
   a) Setting, configuring and managing three password policy in the computer(BIOS, Administrator and Standard User).
   b) Setting and configuring two factor authentication in the Mobile phone.
5. Demonstrate the following:
   a) Security patch management and updates in computer and mobiles.
   b) Wi-Fi security management in computer and mobile.
6. Install and configure computer Anti-virus & Computer Host Firewall.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design appropriate checklists and procedures for secure cyber practices and effective response to cybercrime incidents across various platforms.	Apply
CO2: Illustrate the functioning of cyberspace infrastructure and demonstrate how regulatory frameworks address cyber threats.	Apply
CO3: Analyze privacy and security configurations in social media platforms and digital applications to identify potential risks and propose suitable mitigation strategies.	Analyze
CO4: Apply evolving cybersecurity tools and device protection practices through continuous learning to address emerging digital security challenges.	Apply

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	2	-	-	2	2	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	2	-	-	1	2	2	-	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Cyber Crime Impact in the New Millennium, R. C Mishra. Auther Press. 2010.

T2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, 1st Edition, Wiley India Pvt. Ltd, 2011.

T3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform, Pearson Education, 2001.

Reference Book(s):

R1. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition,Wiley India Pvt. Ltd, 2001

R2. Security Fundamentals of Network by E. Maiwald, McGraw Hill ,2014

R3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K,Dominant Publishers, 2011.

Web Reference(s):

1. https://unacademy.com/content/upsc/study-material/science-and-technology/initiatives-taken-by-indian-government-for-cyber-security/
2. https://cybercrime.gov.in/
3. https://www.meity.gov.in/cyber-security-division
4. https://intellipaat.com/blog/what-is-cyber-security/

Course Code: 23ITE047		Course Title: Intellectual Property Rights (Common to all B.E/B.Tech Programmes)	
Course Category: Minor		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to learn the fundamental concepts of Intellectual Property Law, including patent classifications, trademark strategies, and copyright protections.

Module I **22 Hours**

Intellectual Property: An Introduction: Intellectual Property Law: Patent Law-Copyright Law-Trademark Law- Trade secret Law-Right of Publicity-Paralegal tasks in Intellectual Property Law-Ethical obligations of the paralegal in Intellectual Property Law-Trade secrets: Protectible as a trade secret-Maintaining trade secrets-Protecting an Idea.

Patents: Rights and Limitations: Sources of patent law-Subject matter of Patents: Utility Patents-Plant Patents-Design Patents-Design Patents and copyright-Design Patents and trademarks-Computer Software, Business methods and Patent Protection-Rights under Patent Law-Patent Requirements-Limitations on Patent Rights-Patent Ownership.

Module II **23 Hours**

Patents: Research, Applications, Disputes, and International Considerations: Patent Search Process-Patent Application Process-Patent Infringement-Patent Litigation, International Patent laws.

Principles of Trademark: Trademarks and Unfair Competition-Acquiring Trademark Rights-Types of Marks, Strong Marks Versus Weak Marks-Selecting and Evaluating a Trademark-International Trademark Laws.

Principles of Copyrights: Sources of Copyright Law- The Eight Categories of Works of Authorship-Derivative Works and Compilations- Rights and Limitations: Grant of Exclusive Rights–Copyrights Ownership- International Copyright Laws.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the fundamental concepts of Intellectual Property Law to real-world scenarios.	Apply
CO2: Demonstrate an understanding of the Rights and Limitations of various patents through practical examples.	Apply
CO3: Analyze the process of patent searching and application filing to assess its effectiveness in protecting intellectual property.	Analyze
CO4: Examine the principles of trademark and copyright to differentiate their roles and implications in intellectual property law.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	2	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	2	-	-	-	-	2	-	-	-	-
CO4	-	2	-	-	3	-	-	3	2	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Richard Stim, “Intellectual Property: Copyrights, Trademark and Patents”, Cengage learning, 2nd edition 2012.

Reference Book(s):

R1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, 3rd Edition, 2013.

R2. Prabuddha Ganguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2017.

R3. David Llewelyn, Tanya Frances Aplin, “Intellectual Property Patents, Copyrights, Trademarks & Allied Rights”, Sweet & Maxwell, 2023.

R4. William F. Patry ,"Principles of Intellectual Property: Patents, Trademarks, and Copyrights", Wolters Kluwer, 2023.

Web References:

1. https://ipindia.gov.in/writereaddata/Portal/ev/sectionsindex.html

Course Code: 23AUE050		Course Title: Entrepreneurship Development (Common to all B.E/B.Tech Programmes)	
Course Category: Minor		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to develop entrepreneurial mindset and skills by identifying and validating problems through human-centered design, analyzing markets and customers to create value propositions and MVPs, exploring business models with financial and feasibility analysis, and preparing investible pitch decks to attract stakeholders.

Module I **22 Hours**

Entrepreneurial Mindset

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economics – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Opportunities

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

Prototyping & Iteration

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques. Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

Module II **23 Hours**

Business models & pitching

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

Entrepreneurial Ecosystem

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply entrepreneurial mindset principles to identify societal problems and transform them into viable business opportunities.	Apply
CO2: Develop prototypes using suitable tools and techniques for the validated opportunities through iterative processes.	Apply
CO3: Demonstrate a Business Model Canvas using the Lean approach and pitch the startup idea effectively using storytelling and presentation skills.	Apply
CO4: Analyze customer segments, market size, and niche markets to validate entrepreneurial opportunities through market research and customer interviews.	Analyze
CO5: Evaluate the role and components of the entrepreneurial ecosystem to identify and engage the right ecosystem partners and funding models for startup success.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	1	-	-	-	-	-	-	2	-
CO2	-	-	3	-	1	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	1	1	-	-	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	2	-	-	-	-	-	-	1	1	-	-

High-3; Medium-2; Low-1

Reference Book(s):

1.Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha Entrepreneurship, McGrawHill, 11th Edition,2020.

2.Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business,2011.

3.Blank, S. G., & Dorf, B. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.2012.

4.Roy, R. Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press,2017.

5.Osterwalder, A., & Pigneur, Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons,2010.

OPEN ELECTIVES

Course Code: 23ECO001		Course Title: Consumer Electronics	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week): 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on fundamentals and uses of consumer electronics. It focuses on how different home appliances, entertainment systems, and communication gadgets operate as well as how they integrate with modern technologies like microcontrollers and the Internet of Things. Students will investigate how consumer electronics like communication systems, smart appliances, and audio systems are made, used, and operated.

Module I **22 Hours**

Electronic Fundamentals and Entertainment systems

Semi conductor devices : Diodes, Transistors, Logic gates, ADC, DAC, Introduction to Microcontroller, Microcontroller in consumer Electronics.

Entertainment Electronics : Audio systems – Construction and working principle of Microphone, Loud speaker, stereo, 2.1 home theatre, 5.1 home theatre.

Display systems : CRT, LCD, LED, OLED, QLED. Video players : DVD, blue RAY. Recording systems : Digital camera and Camcorders.

Module II **23 Hours**

Home appliances and Communication systems

Home Enablement systems: RFID, Lighting control, Washing machines, Air conditioners, vacuum cleaners, UPS and Inverters, Microwave oven, Dish washer, Induction stoves, Smart Refrigerators, Smart locks, smart floor.

Communication systems: Cordless phones, Fax machines, Smart phones and Smart watches, Tablet, WiFi, Blue tooth, Video conference systems – Web/IP camera, Internet enabled systems, GPS and tracking systems.

Product compliance : Standards related to fire hazards and electrical safety, EMI/EMC requirements.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the working principles of semiconductor devices like diodes, transistors, and logic gates in basic electronic circuits.	Apply
CO 2: Develop skills in designing and implementing consumer electronics systems, such as microcontroller-based entertainment and smart home electronics.	Apply
CO 3: Analyze and assemble entertainment and display systems such as home theaters, microphones, and LED/OLED screens.	Analyze
CO 4: Integrate knowledge of home automation technologies like RFID, smart lighting, and appliances for smart home solutions.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Thomas L Floyd “Electronic devices” 1oth Edition Pearson Education Asia 2018.

T2. Philp Hoff “Consumer electronics for Engineers” – Cambridge university press, 1998.

Reference Book(s):

R1. Bali S P, Consumer Electronics, Pearson Education, 2007 Edition.

R2. R G Gupta, Khanna Publishers, Consumer Electronics devices and systems.

R3. Consumer Electronics: Devices and Systems – Allan W. Moffet

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_mm03/preview
2. https://www.semtech.com/applications/consumer-electronics
3. https://www.geeksforgeeks.org/application-of-physics-in-consumer-electronics/

Course Code: 23ECO002		Course Title: Artificial Intelligence	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week):3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is designed to impart comprehensive knowledge of Artificial Intelligence (AI) by enabling students to identify suitable AI methods for various applications. It aims to explain the fundamentals of knowledge representation and provide insights into different reasoning techniques. The course also covers key concepts in planning and machine learning, helping students interpret their significance and applications. Additionally, it explores the architecture and functioning of typical expert systems, equipping learners with a solid understanding of their components and design.

Module I **22 Hours**

Introduction to Artificial Intelligence: Introduction to AI, Problem formulation, Production systems, Uninformed Search-Depth first and Breath first search, Informed Search-Generate and test, Hill Climbing, Best first search algorithms, Application of AI in Game playing.

Representation of Knowledge: Introduction to Knowledge representation and mapping-types of knowledge representation, structured form of knowledge representation, Knowledge representation using propositional and predicate logic, Resolution in propositional and predicate logic, Forward and Backward chaining algorithm, Application of knowledge representation in AI.

Reasoning: Introduction to Non-monotonic reasoning-Logics-Implementation issues, Probability and Bayes theorem–Bayesian networks and its types, Fuzzy logic and its application in air conditioning system.

Module II **23 Hours**

Knowledge Acquisition and Machine Learning: Knowledge Acquisition process – Meta knowledge, Components of planning system – Understanding, Learning –Rote learning, Explanation based Learning, Inductive Learning, Application of AI for Natural language processing.

Expert Systems: Architecture of expert systems, Roles of expert systems, Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells, Application of AI for robotics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify a suitable Artificial Intelligence methods for solving the given problems and apply the AI methods for solving problems	Apply
CO 2: Implement logic-based and rule-based knowledge representation methods for solving structured problems.	Apply
CO 3 : Apply reasoning approaches and fuzzy logic principles to analyze and solve uncertainty-based problems.	Apply
CO 4: Demonstrate the application of planning strategies and machine learning techniques for effective problem-solving in AI.	Apply
CO 5: Develop solutions to real-world societal problems by applying the architecture and functions of expert systems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	-	2	-	-	-	-	-	3	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.R.B.Mishra, “Artificial Intelligence” PHI learning private ltd, 2011.

T2.Kevin Night and Elaine Rich, Nair B. “Artificial Intelligence(SIE)”,McGraw Hill- 2008.

Reference Book(s):

R1. Peter Jackson, “IntroductiontoExpertSystems”,3rd Edition, Pearson Education,2007.

R2. Stuart Russel and Peter Norvig, “AI – A Modern Approach”, 2nd Edition, Pearson Education2007.

R3.Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education2013

R4.N.P.Padhy,“Artificial Intelligence and Intelligent systems” Oxford University press,4th Edition, 2008.

Web References:

1.http://nptel.ac.in/courses/106105077/

2.https://nptel.ac.in/courses/106102220

3.https://www.tutorialspoint.com/artificial_intelligence/index.htm

Course Code: 23ECO003		Course Title: In-Vehicle Networking	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge onautomotive communication protocols such as LIN, CAN, FlexRay, and MOST, focusing on their architecture, operation, and integration in vehicle networks.

Module I **22 Hours**

Introduction

Introduction to Computer Networks - Network Topologies - Types of Networks: Local Area Networks, Wide Area Networks - Vehicle network Architecture - Vehicle network.

Protocols for low data rate applications

Overview of general purpose networks and protocols –Ethernet, TCP, UDP, IP.

LIN standard overview –workflow concept-applications –LIN protocol specification –signals – Frame transfer –Frame types –Schedule tables –Task behaviour model –Network management – status management.

Module II **23 Hours**

Protocol for medium data rate applications

Overview of CAN –fundamentals –Message transfer –frame types-Error handling –fault confinement-Bit time requirements. Introduction to CAN open –TTCAN –Device net –SAE J1939

Protocol for infotainment and Protocols for safety critical applications

MOST overview–data rates–data types–topology –application areas. FlexRay-Introduction – network topology –ECUs and bus interfaces –controller host interface and protocol operation controls –media access control and frame and symbol processing – coding/decoding unit

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Applythe characteristics of general-purpose protocols (Ethernet, TCP/IP) and automotive protocols (LIN) to select appropriate communication solutions for given vehicle networking scenarios.	Apply
CO2: Apply medium data rate communication protocols to model inter-ECU communication in embedded vehicle systems.	Apply
CO3: Demonstrate the working of the CAN protocol including message framing, error handling mechanisms, and fault confinement.	Apply
CO4: Analyze the LIN protocol workflow, including frame types, signal processing, schedule tables, and task behavior models for low data rate automotive applications.	Analyze
CO5: Involve in a team and a*ssess* the societal, safety, and environmental implications of adopting automotive communication protocols in intelligent transportation systems and autonomous vehicles. Make an oral presentation (For internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	2	-	2	2	-	2	2	-	2	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. J.Gabrielleen, Automotive in-vehicle networks, John Wiley & Sons, Limited, 2008

T2.Indra Widjaja, Alberto Leon-Garcia, —Communication Networks: Fundamental Concepts and Key Architectures, McGraw-Hill College; 1st edition, 2000.

Reference Book(s):

R1.Olaf Pfeiffer, Andrew Ayre, Christian Keydel, “Embedded Networking with CAN and CANopen”, Annabooks/Rtc Books, 2003

R2.Robert Bosch, Bosch automotive networking, Bentley publishers,2007

R3.Society of automotive engineers, In-vehicle networks ,2015

Web References:

1.https://nptel.ac.in/courses/108108123

2.https://www.logic-fruit.com/blog/can/can-lin-and-flexray explained/?srsltid=AfmBOopNjWrqlsgQH_2vZql51_Ai9RouIlsj0Jp-sE2xHntWF5uPmD5I

Course Code: 23ECO004		Course Title: Data Science for Engineering	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on data science by providing a foundation for the students to develop a strong understanding of data science principles and their applications in engineering.

Module I **22 Hours**

Mathematical foundation - Introduction to data science - vectors, matrices to represent relations between data, and necessary linear algebraic operations on matrices - product of matrix & vector, rank, null space - projection of vectors, eigen vectors and eigenvalue decomposition.

Descriptive Statistics - probability distribution - conditional probability, Bayes's theorem, random variables - mean, variance, covariance, covariance matrix - normal distributions, central limit theorem, statistical hypothesis testing - confidence interval for estimates, idea behind Gradient descent - fitting models using Gradient descent.

Module II **23 Hours**

Machine Learning Algorithms: Simple Linear Regression-Multivariate linear regression-Logistic Regression – Classification using logistic regression, k-Nearest Neighbors (k-NN), Decision tree – Naive Bayes- Ensemble Methods – Random Forest, Feature Generation and Feature Selection – Feature Selection algorithms – Filters, Wrappers, embedded method.

Clustering: Choosing distance metrics – Different clustering approaches –centroid based k-means (Lloyd's algorithm), hierarchical agglomerative clustering, Density-based DBSCAN – Relative merits of each method – clustering tendency and quality.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Understand the mathematical foundations, statistical concepts, and machine learning algorithms relevant to data science in engineering.	Understand
CO2:Apply various data science principles, such as matrix operations, probability distributions, hypothesis testing to real-world societal engineering problems.	Apply
CO3: Apply various machine learning algorithms to interpret the data for engineering applications using python.	Apply
CO4:Analyze the effectiveness of different machine learning modelsand assess the application of gradient descent for model fitting in real-world scenarios.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Joel Grus, “Data Science from Scratch: First Principles with Python”, O’Reilly Media, second edition, 2019

T2.Pierson, Lillian, “ Data science for dummies”, John Wiley & Sons, 2021.

Reference Book(s):

R1.Mueller, John Paul, and Luca Massaron,“Machine learning for dummies”, John Wiley & Sons, 2021.

R2.Davy Cielen, Mohamed Ali, Arno Meysman, “Introducing Data Science: Big Data, Machine Learning, and More Using Python Tools”, 2023.

R3.Haider, Murtaza,“Getting started with data science: Making sense of data with analytics”, IBM Press, 2015.

Web References:

1.https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2.https://scikit-learn.org/stable/

Course Code: 23ECO005		Course Title: Internet of Everything	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week): 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on IoT, embedded systems, and data communication

Module I **22 Hours**

IoE Architecture, Technologies & Networking Fundamentals : Evolution of IoT - IoE: Definition, Scope, and Industrial Impact, The Four Pillars of IoE: People, Process, Data, Things – Interconnectivity, IoE Layered Architecture: Sensing Layer, Network Layer, Middleware, Application, Protocol Stack Overview: MQTT, CoAP, AMQP, HTTP, DDS, IoE Communication Technologies: Short-Range: ZigBee, BLE, NFC, Long-Range: LoRa, SigFox, NB-IoT, Internet Connectivity: Wi-Fi, 4G/5G, Ethernet IPv6, 6LoWPAN – Routing Protocols for IoE. Cloud-centric vs. Edge-centric vs. Fog-based deployments

Case Study: Smart Water Management using IoE Networks.

Module II **23 Hours**

Data Management, Security & Applications of IoE : Data Flow in IoE: Collection → Aggregation → Transmission → Storage → Visualization Data Handling Techniques: Compression, Synchronization, Prioritization Role of Middleware Platforms in IoE Ecosystems Cloud and Edge Integration for Scalable Data Processing IoE Security Concerns: Authentication, Authorization, Privacy, Data Integrity, Lightweight Security Protocols for Constrained Devices Real-time Constraints and Energy Efficiency in IoE, Applications of IoE: Smart Cities (Lighting, Traffic, Parking) Smart Homes (Automation, Energy Use)Smart Healthcare (Monitoring, Alerts) Smart Agriculture (Sensor Integration, Precision Irrigation)Industrial Automation and Asset Monitoring. Case Study: Comparative Deployment of IoE in Smart Cities vs. Smart Agriculture

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the evolution, principles, and architecture of the Internet of Everything	Understand
CO 2: Identify and compare networking protocols and technologies for IoE communication	Apply
CO 3: Analyze appropriate techniques to manage data flow, storage, and middleware in distributed IoE systems.	Analyze
CO 4: Develop suitable security, privacy, and performance enhancement techniques in real-world IoE systems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.ArshdeepBahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015

T2.RajkumarBuyya et al., Internet of Things: Principles and Paradigms, Elsevier, 2016

Reference Book(s):

R1.Samuel Greengard, The Internet of Things, MIT Press, 2015

R2.Jean-Philippe Vasseur, Interconnecting Smart Objects with IP, Morgan Kaufmann, 2010

R3.David Hanes et al., IoT Fundamentals, Cisco Press, 2017

Web References:

1.https://nptel.ac.in/courses/106105166

2.https://www.techrepublic.com/topic/internet-of-things/

3.https://ocw.mit.edu/courses/media-arts-and-sciences/mas-961-internet-technology-in-local-and-global-communities-fall-2004/

Course Code:23ECO006		Course Title: Machine Vision System	
Course Category:Minor		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on machine vision fundamentals& machine vision algorithms. It also focuses on pattern recognition techniques and the application of machine vision in real-time inspection and measurement tasks.

Module I **23 Hours**

Introduction to Machine Vision: Nature of Vision, Vision System Tasks, Image Representations and Properties, Mathematical and Physical Background, Data Structures for Image Analysis, Basic Image Filtering Operations.

Image Acquisition and Conversion: Illumination, Electromagnetic Radiation, Light Sources, Interaction of Light and Matter, Lenses, Pinhole Cameras, Gaussian Optics, Depth of Field, Telecentric Lenses, Lens Aberrations, Camera Technologies (CCD, CMOS, Color Cameras), Sensor Sizes, Camera-Computer Interfaces, Image Acquisition Modes, Camera Calibration, Camera Models, and Calibration Accuracy.

Module II **22 Hours**

Machine Vision Algorithms: Image Enhancement, Gray Value Transformations, Image Smoothing, Thresholding, Connected Components Extraction, Feature Extraction, Morphology, Edge Detection, Image Segmentation, and Geometric Primitive Fitting.

Pattern Recognition: Template Matching (Gray-Value-Based, with Rotation and Scaling), Optical Character Recognition, Classifiers (Parametric, Non-Parametric, Nearest Neighbor, Neural Networks).

Machine Vision Applications: Serial Number Reading, Saw Blade Inspection, Ball Grid Array (BGA) Inspection, Surface Inspection, Punched Sheet Inspection, and Pose Verification of Resistors.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply appropriate machine vision techniques to solve practical image analysis and interpretation problems.	Apply
CO 2: Analyze the performance of machine visionsystems for various industrial applications.	Analyze
CO 3: Design various algorithms for feature extraction, pattern recognition, and decision-making in real-world scenarios.	Create
CO 4: Develop a simple simulation based mini-project related to Machine vision applications and demonstrate as a team or Individual (For internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	1	1		1	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Carsten Steger, Markus Ulrich, and Christian Wiedemann "Machine Vision Algorithms and Applications" Wiley-VCH; 1st Edition, 2007.

T2.Alexander Hornberg, "Handbook of Machine Vision" John Wiley & Sons, (2007).

Reference Book(s):

R1.Rafael C. Gonzaies, Richard E. Woods, Digital Image processing, Pearson Education, 2004.

R2.E.R.Davies, "Machine Vision: Theory, Algorithms, Practicalities" Elsevier, Technology &Engineering , 2004.

R3.Harley R. Myler, "Fundamentals of Machine Vision", SPIE Press,1999.

Web References:

1.https://onlinecourses.nptel.ac.in/noc16_ma05

2.https://nptel.ac.in/courses/122101003/2

3.https://nptel.ac.in/syllabus/111104092/

Course Code:23ECO007		Course Title: Soft Computing	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on Soft Computing, Fuzzy Theory, Neural Networks, and Genetic Algorithms. Also, it focuses on applying these concepts to solve problems and optimize solutions effectively.

Module I **23 Hours**

Introduction to Soft Computing: Soft Computing Constituents, Evolution from Conventional AI to Computational Intelligence.

Neural Networks: Basics, Characteristics, Learning Methods, Taxonomy, Evolution, Models, Technologies, and Applications. McCulloch-Pitts Neuron, Linear Separability, Hebb Network, Perceptron Networks, Backpropagation Network (BPN), Radial Basis Function (RBF), Unsupervised and Supervised Learning Networks.

Fuzzy Logic Fundamentals: Crisp and Fuzzy Sets, Crisp and Fuzzy Relations, Tolerance and Equivalence Relations, Membership Functions, Fuzzification and Defuzzification Methods, Fuzzy Inference Systems.

Module II **22 Hours**

Genetic Algorithms: Introduction, Comparison with Traditional Optimization Techniques, Basic Concepts, Operators (Encoding, Fitness Evaluation, Crossover, Mutation), Genetic Programming, Multilevel Optimization.

Hybrid Soft Computing Techniques: Neuro-Fuzzy Hybrid Systems, Genetic-Neuro Hybrid Systems, Genetic-Fuzzy and Fuzzy-Genetic Hybrid Systems.

Applications of Hybrid Techniques: Fusion of Multispectral and SAR Images, Optimization of Traveling Salesman Problem Using GA, Development of Hybrid Fuzzy Controllers with Soft Computing Approaches.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply appropriate soft computing techniques to solve complex and real-world problems.	Apply
CO 2: Analyze various soft computing techniques based on their applicability to real-world problems.	Analyze
CO 3: Analyze the behavior of intelligent systems by using suitable computational models.	Analyze
CO 4: Develop a simple simulation based mini-project related to Soft computing techniques and demonstrate as a team or individual (for internal assessment only)	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	1	1		1	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.

T2. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.

Reference Book(s):

R1.S.Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.

R2.David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.

R3.Anupam - shukla, RituTiwari, Rahul Kala, “Real life applications of Soft computing”, CRC press, 2010.

Web References:

1.https://archive.nptel.ac.in/courses/106/105/106105173/

2.https://onlinecourses.nptel.ac.in/noc22_ee21/preview

3.https://onlinecourses.nptel.ac.in/noc21_me10/preview