K L E F

Department of Electronics and Communication Engineering
Academic Year 2020-21
Mapping of ECE Department Mission Statement with POs, PSOs and PEOs
Mission statement of K L E F:

Vision:

To be a globally renowned university.

Mission

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

Vision and Mission statement of ECE department

VISION

- To evolve into a globally recognized department in the frontier areas of Electronics & Communication Engineering (ECE).

MISSION

M1- To produce graduates having professional excellence.
M2- To carry out quality research having social & industrial relevance.
M3- To provide technical support to budding entrepreneurs and existing Industries**.**

Academic Goals

1. To offer academic flexibility by means of Choice based credit systems and the like.
2. To identify and introduce new specializations and offer programs in emerging areas therein
3. To incorporate into the curriculum the Application orientation and use high standards of competence for academic delivery
4. To design and implement educational system adhering to outcome based International models.
5. To introduce and implement innovation in teaching and learning process to strengthen academic delivery
6. To offer academic programs at UG, PG, doctoral, Post-Doctoral which are industry focused, and incorporates Trans-discipline, inter-discipline aspects of the education system
7. To deliver higher education that includes technologies and meeting the global requirements

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

- **PEO1:** Practice engineering in a broad range of industrial, societal and real world applications.
- **PEO2:** Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.
- **PEO3:** Conduct themselves in a responsible, professional, and ethical manner.
- **PEO4:** Participate as leaders in their fields of expertise and in activities that support service and economic development throughout the world.

Program Outcomes

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and

	ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES

PSO1	An ability **to Understand the theoretical and mathematical concepts to analyze real time problems.**
PSO2	An Ability **to Design and Analyze systems based on the theoretical and Practical Knowledge**

Mapping of mission statements with program educational objectives

	M1	M2	M3
PEO1	✓	✓	✓
PEO2	✓	✓	✓
PEO3	✓		✓
PEO4	✓	✓	✓

Mapping of PEOs with POs

	PEO1	PEO2	PEO3	PEO4
PO1	✓	✓		
PO2	✓	✓		
PO3	✓	✓		✓
PO4	✓	✓		✓
PO5	✓	✓		
PO6	✓	✓	✓	✓
PO7	✓			✓
PO8	✓		✓	
PO9	✓		✓	✓
PO10	✓		✓	✓
PO11	✓	✓		✓
PO12	✓			✓
PSO1	✓	✓		
PSO2	✓	✓		

(DEEMED TO BE UNIVERSITY)

SNO	COURSE CODE	COURSE NAME	L	T	P	S	Cr	Pre requisites
I		**HUMANITIES & SOCIAL SCIENCES**						
1	20UC1101	INTEGRATED PROFESSIONAL ENGLISH	0	0	4	0	2	NIL
2	20UC1202	ENGLISH PROFICIENCY	0	0	4	0	2	NIL
3	20UC2103	PROFESSIONAL COMMUNICATION SKILLS	0	0	4	0	2	NIL
4	20UC2204	CORPORATE COMMUNICATION SKILLS	0	0	4	0	2	NIL
5	20UC3005	APTITUDE BUILDER I	0	0	4	0	2	NIL
6	20UC3006	APTITUDE BUILDER II	0	0	4	0	2	NIL
7		FOREIGN LANGUAGE ELECTIVE	2	0	0	0	2	NIL
8	20UC0007	Indian Heritage and Culture	2	0	0	0	0	NIL
9	20UC0008	Indian Constitution	2	0	0	0	0	NIL
10	20UC0009	Ecology & Environment	2	0	0	0	0	NIL
11	20UC0010	Universal Human Values & Professional Ethics	2	0	0	0	0	NIL
12	20UC0011	Entrepreneurship	2	0	0	0	0	NIL
Total Credits							14	
II		**BASIC SCIENCES**						
1	20MT1101	MATHEMATICS FOR COMPUTING	2	2	0	2	4.5	NIL
2	19MT2102	MATHEMATICS FOR ENGINEERS	2	1	0	0	3	NIL
3	20UC1102	DESIGN THINKING AND INNOVATION I	1	0	0	4	2	NIL
4	20UC1103	DESIGN THINKING AND INNOVATION II	1	0	0	4	2	NIL
5	19BT1001	BIOLOGY FOR ENGINEERS	2	0	0	0	2	NIL
Total Credits							13.5	
		SCIENCE ELECTIVE - 1						
1	19PH1008	PHYSICS FOR ELECTRONICS ENGINEERING	3	0	2	0	4	NIL
2	19PH1004	SOLID STATE PHYSICS	3	0	2	0	4	NIL
3	19PH2101	QUANTUM MECHANICS FOR ENGINEERS	3	1	0	0	4	NIL
		SCIENCE ELECTIVE - 2						
1	19CY1101	ENGINEERING CHEMISTRY	3	0	2	0	4	NIL
2	19CY1003	CHEMISTRY & BIOINFORMATICS FOR ENGINEERS	3	0	2	0	4	NIL
3	19CY1004	ORGANIC ELECTRONICS	3	0	2	0	4	NIL
Total Credits							8	
III		**ENGINEERING SCIENCES**						
1	**20SC1101**	COMPUTATIONAL THINKING FOR DESIGN	**3**	**0**	**2**	**6**	**5.5**	**NIL**
2	20ME1103	DESIGN TOOLS WORKSHOP - I	0	0	4	0	2	NIL
3	19SC1202	DATA STRUCTURES	3	0	2	4	5	NIL
4	19SC1209	DESIGN TOOLS WORKSHOP - II	0	0	4	0	2	NIL
5	19SC1203	OBJECT ORIENTED PROGRAMMING	2	0	4	0	4	NIL
6	20EC1101	DIGITAL LOGIC & PROCESSORS	3	0	2	0	4	NIL

7	19EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	2	0	0	0	2	20EC1101
8	20EC1213	DESIGN of BASIC ELECTONIC CIRCUITS	3	0	0	0	3	NIL
9	20EC2111	ELECTRONIC SYSTEM DESIGN WORKSHOP	1	0	2	2	2.5	NIL
10	20EC2214	IOT Workshop	1	0	0	4	2	NIL
11	20EC2112	IT Workshop	1	0	2	0	2	NIL
Total Credits							34	
		PROFESSIONAL CORE COURSES						
1	19EC2103	Analog Electronic Circuit Design	3	0	2	2	4.5	NIL
2	19EC2104	Communication Signals & System Design	3	1	0	0	4	NIL
3	19EC2105	Analog And Digital Communication	3	0	3	0	4.5	NIL
4	20EC2106	Embedded Controllers & Embedded System Design	3	0	2	2	4.5	NIL
5	19EC2207	Electromagnetic Fields & Applications	3	1	0	0	4	NIL
6	19EC2208	Digital Signal Processing	3	0	2	0	4	NIL
7	20EC2209 A	Statistics, AI & ANN	3	0	0	2	3.5	NIL
8	20EC2209	AI, ANN Tools And Applications	3	0	0	0	3	NIL
9	19EC2210	Data Networks And Protocols	3	0	2	0	4	NIL
Total Credits							33	
SKILLING COURSES								
1	20TS3101	Technical Proficiency / Entrepreneurial Incubation	0	0	0	12	3	NIL
2	20TS3202	Technical Proficiency / Technopreneurship	0	0	0	12	3	NIL
3	20TS4103	Technical Proficiency / Entrepreneural Skilling	0	0	0	12	0	NIL
4	20TS4204	Technical Proficiency / Entrepreneural Skilling	0	0	0	12	0	NIL
Total Credits							6	
TERM PAPER & PROJECT								
1	20IE2050	Social Internship	0	0	0	8	2	NIL
2	20IE3050	Technical Internship	0	0	0	8	2	NIL
3	20IE3150	Midgrade Capstone Project 1	0	0	0	8	2	NIL
4	20IE3250	Midgrade Capstone Project 2	0	0	0	8	2	NIL
5	20IE4150	Capstone Project 1	0	0	0	24	6	NIL
6	20IE4250	Capstone Project 2	0	0	0	24	6	NIL
7	19IE4050	Practice School	0	0	0	24	6	NIL
8	19IE4051	Internship	0	0	0	24	6	NIL
Total Credits							20	
FLEXI-CORE								

1	FC-1	FLEXI-CORE-1					4	
2	FC-2	FLEXI-CORE-2					4	
3	FC-3	FLEXI-CORE-3					4	
Total Credits							12	
OPEN ELECTIVES								
1	OE-1	OPEN ELECTIVE-1	3	0	0	0	3	NIL
2	OE-2	OPEN ELECTIVE-2	3	0	0	0	3	NIL
Total Credits							6	
PROFESSIONAL ELECTIVES								
1	PE-1	PROFESSIONAL ELECTIVE-1					3	
2	PE-2	PROFESSIONAL ELECTIVE-2					3	
3	PE-3	PROFESSIONAL ELECTIVE-3					3	
4	PE-4	PROFESSIONAL ELECTIVE-4					3	
5	PE-5	PROFESSIONAL ELECTIVE-5					3	
6	PE-6	PROFESSIONAL ELECTIVE-6					3	
Total Credits							18	
Grand Total Credits							**164.5**	

Flexi core courses

1	19EC3015	VLSI Design	3	0	2	0	4	NIL
2	19EC3016	Wireless Communications	3	0	2	0	4	NIL
3	19EC3017	RF System Design	3	0	2	0	4	NIL
4	19EC3018	Biomedical Electronics & Iot For Healthcare	3	0	2	0	4	NIL
5	19EC3019	Electronics Instruments & Automation	3	0	2	0	4	NIL
6	19EC3020	System Engineering, Operation Research & Designing	3	0	2	0	4	NIL
7	19EC3021	Electrical Technologies & Solar Power Systems	3	0	2	0	4	NIL
8	19EC3022	Advanced Course in Soft Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)	3	0	2	0	4	NIL
9	20EC3023	Database Management Systems	3	0	2	0	4	NIL

Specialization Elective Courses

1	IOT	Module-1	Programming Technologies-C & Data Structure, Python	3	0	0	0	3	NIL
		Module-2	Introduction to IOT & IOT Platforms	3	0	0	0	3	NIL
		Module-3	Networking and Wireless Technologies	3	0	0	0	3	NIL
		Module-4	IoT Protocols	3	0	0	0	3	NIL
		Module-5	Edge ,Cloud Computing and Analytics	3	0	0	0	3	NIL
2	VLSI	20EC3061	Low Power VLSI	3	0	0	0	3	NIL
		20EC3062	Algorithms for VLSI Design Automation	3	0	0	0	3	NIL
		20EC3063	ASIC & FPGA Chip Design	3	0	0	0	3	NIL
		20EC3064	VLSI Sub-system Design and Design for Testability	3	0	0	0	3	NIL
		20EC3065	Semiconductor Memories & MEMS	3	0	0	0	3	NIL
		20EC3066	Analog & Digital IC Applications	3	0	0	0	3	NIL

3	Renewable energy & Smart cities	20EC3051	Wireless sensor Networks & IOT Applications	3	0	0	0	3	NIL
		20EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	3	0	0	0	3	NIL
		20EC3053	Electronic Systems for Renewable Energy & Smart Grid	3	0	0	0	3	NIL
		20EC3054	IOT Applications & Smart Cities	3	0	0	0	3	NIL
		20EC3055	Systems for Smart Cities & Smart Villages	3	0	0	0	3	NIL
4	SIGNAL PROCESSING	20EC3081	Speech Signal Processing	3	0	0	0	3	NIL
		20EC3082	Digital Image Processing	3	0	0	0	3	NIL
		20EC3083	Bio Medical Image Analysis	3	0	0	0	3	NIL
		20EC3084	Statistical Signal Processing	3	0	0	0	3	NIL
		20EC3085	Adaptive Signal Processing	3	0	0	0	3	NIL
		20EC3086	Detection and Estimation of Signals	3	0	0	0	3	NIL
		20EC3087	Bio Medical Signal Analysis	3	0	0	0	3	NIL
5	ROBOTICS & AUTOMATION	20EC3071	Control Systems & Introduction to Robotics	3	0	0	0	3	NIL
		20EC3072	Autonomous Vehicles & Automotive Electronics	3	0	0	0	3	NIL
		20EC3073	Advanced Robotics	3	0	0	0	3	NIL
		20EC3074	Computer Vision & Applications	3	0	0	0	3	NIL
		20EC3075	Human Machine Interface & Brain Machine Interface	3	0	0	0	3	NIL
		20EC3076	Designing Automation Systems & Assistive Robotic Systems	3	0	0	0	3	NIL
6	BIO-MEDICAL INSTRUMENTATION	20EC4071	Automated Vehicles & Avionics	3	0	0	0	3	NIL
		20EC4072	Calibrations and Designing Advanced Instruments	3	0	0	0	3	NIL
		20EC4073	Biological & Cyber-Physical Systems	3	0	0	0	3	NIL
		20EC4074	Electronic Instruments & Biomedical Applications	3	0	0	0	3	NIL
		20EC3072	Autonomous Vehicles & Automotive Electronics	3	0	0	0	3	NIL
		20EC3075	Human Machine Interface & Brain Machine Interface	3	0	0	0	3	NIL
7	RF & MICROWAVE	20EC3091	Microwave Engineering	3	0	0	0	3	NIL
		20EC3092	Antenna Design & Wave Propagation	3	0	0	0	3	NIL
		20EC3093	Radar Engineering & Navigational Aids	3	0	0	0	3	NIL
		20EC3094	Modern Antennas, Millimeter Waves & Applications	3	0	0	0	3	NIL
		20EC3095	Electronic Warfare, EMI & EMC	3	0	0	0	3	NIL
8	DATA COMMUNICATION	20EC4051	Information Theory & Coding	3	0	0	0	3	NIL
		20EC4052	4G Wireless Technologies & Cellular Communications	3	0	0	0	3	NIL
		20EC4053	Satellite Communications	3	0	0	0	3	NIL
		20EC4054	Optical Communication & Network	3	0	0	0	3	NIL
		20EC4055	Next Generation Wireless Technologies	3	0	0	0	3	NIL

			(WCDMA, GPRS, GSM, UMTS)						
		20EC4061	TCP/IP & Other Protocol Suite	3	0	0	0	3	NIL
		20EC4062	VoIP Systems & Broad Band Networks	3	0	0	0	3	NIL
		20EC4063	5G Mobile, Wireless Technologies & IEEE 802 Standards	3	0	0	0	3	NIL
		20EC4064	Cloud-Computing & Network Security	3	0	0	0	3	NIL
		20EC4065	IP Multimedia Sub-System & Emerging Technologies	3	0	0	0	3	NIL

Network Security, Data Science & Big Data, IOT, Artificial Intelligence & Machine Learning specializations are adapted from Dept of CSE.

S. No	Course Code	Course Name	CO No	CO	PO												PSO	
					1	2	3	4	5	6	7	8	9	10	11	12	1	2
I	**HUMANITIES & SOCIAL SCIENCES**																	
1	20UC1101	Integrated Professional English	1	Understand the concepts of grammar to improve communication, reading, and writing skills										2				
			2	Demonstrate required knowledge over Dos and Don'ts of speaking in the corporate context. Demonstrate ability to face formal situations / interactions.									3					
			3	Understand the varieties of reading and comprehend the tone and style of the author. Skim and scan effectively and appreciate rhetorical devices									2					
			4	Apply the concepts of writing to draft corporate letters, emails, and memos										3				
2	20UC1202	English Proficiency	1	Demonstrating different interpersonal skills for employability								3						
			2	Distinguishing business essential skills									2					
			3	Classifying social media and corporate communication skills												3		
			4	Applying analytical thinking skills												3		
3	20UC2103	Professional Communication Skills	1	Able to spot the common grammatical errors related to sentence structure, preposition, concord, relative and conditional clauses and parallel structures. The learner should be efficient to construct a context-determined text in addition to learning Technical Writing Skills.									2	3				
			2	Able to read, understand, and interpret a text intrinsically as well as extrinsically. The learner can browse a text quickly to come-up with a gist and personal interpretation. Able to create a healthy work-environment and prove to be an asset or one of the most reliable resources to the organization.								3						
			3	Apply the concepts of time and work; men-time-work problems based on wages, pipes and cisterns. Apply the concepts of time and distance and solve the problems related to average speed, relative speed.	3													

			4	Apply Venn diagrams to find out appropriate conclusions from the given statements. Apply the logical implications and also the negations of various connectives to find the solutions. Analyze the data and represent in the form of Venn diagrams to find relations between any given set of elements.	2				3									
4	20UC2204	Corporate Communication Skills	1	Verbal ability					2	3								
			2	Soft skills							3			3				
			3	Quantitative aptitude	3				2									
			4	Reasoning	3				2									
5	20UC3005	Aptitude Builder I	1	Apply the strategies and techniques for conversations in different contexts. Analyze the different parameters and formats of written technical communication and apply in everyday work and life.								2		3				
			2	Analyze the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.								3		2				
			3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest	1				3									
			4	Analyze the series of numbers or letters to predict the next number in the series or to find the analogy. Analyze the data to find the codes in the process of encoding and decoding. Apply the given set of conditions to select a team from a group of members.	1													
6	20UC3006	Aptitude Builder II	1	Apply the strategies and techniques for conversations in different contexts. Analyze the different parameters and formats of written technical communication and apply in everyday work and life.								3		3				
			2	Analyze the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.								2		2				
			3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest	1				3									

			4	Analyze the series of numbers or letters to predict the next number in the series or to find the analogy. Analyze the data to find the codes in the process of encoding and decoding. Apply the given set of conditions to select a team from a group of members.	1													
7	20UC0007	*Indian Heritage and Culture	1	To familiarize with various aspects of the culture and heritage of India through ages.	1													
			2	To acquaint with the contributions of Indians in the areas of languages and literature, religion and philosophy	1													
			3	To understand the Social structure and the spread of Indian culture abroad	1													
			4	To know the development of Science and Technology in India through ages and to appreciate the contributions of some of the great Indian scientists	1													
8	20UC0008	*Indian Constitution	1	To understand Constitutional development after Independence												2		
			2	To learn the fundamental features of the Indian Constitution												3		
			3	To get a brief idea of the powers and functions of Union and State Governments												2		
			4	To understand the basics of working of Indian Judiciary and the Election Commission												2		
9	20UC0009	*Ecology & Environment	1	Understand the importance of Environmental education and conservation of natural resources.						1								
			2	Understand the importance of ecosystems and biodiversity.												3		
			3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.						1								
10	20UC0010	*Universal Human Values & Professional Ethics (online)	1	Understand and identify the basic aspiration of human beings								3						
			2	Envisage the roadmap to fulfill the basic aspiration of human beings.								1						
			3	Analyze the profession and his role in this existence.								1						
11	20UC0011	*Entrepreneurship	1	Learn critical elements of entrepreneurship and its development from institution's perspective								1						

			2	Understand the process of entrepreneurship and its eco system in an educational institute to fit in entrepreneurship zone								1						
			3	Understand & Learn Design Thinking skills towards product innovation & prototype design								1						
			4	Learn the essential component of planning a new startup, including a. Recognizing viable market opportunities & Market assessment via secondary market research and customer discovery via primary market research b. Creating a profitable business model and an executable business plan c. Protecting the intellectual property at the heart of their technology company d. Developing financial projections that are aligned with the proposed business plan								3						
			5	Study the practices of working with Co-students in other discipline, integrating creative business strategies with solid engineering and effectively working in multi disciplinary teams								1						
			6	Recognize the methods of making decisions in highly uncertain and unstructured environments to take feedback from a large variety of sources that use it to improve their business plans, or help them to ‘pivot’ and find alternative ideas or approaches								1						
*Note: * marked course are audit courses*																		
II	**BASIC SCIENCES**																	
1	20MT1101	Mathematics for Computing	1	Model a system of equations for real world applications in engineering, physical and biological sciences, computer science, finance, economics and solve them through matrix algebra	3													
			2	Model basic and computational techniques on discrete structures like relations, orders, functions & FSM, Lattices, and propositional &predicate logic	2													
			3	Model real world structures and their related applications using advanced discrete structures like graphs and trees.	2													
			4	Model the given Statistical data for real world applications in Engineering science, Economics and Management.	2													
			5	Demonstrate the Aptitude and Reasoning skills (Tests in skilling	2													

				hours)														
2	19MT2102	Mathematics for Engineers	1	Apply differential and integral calculus to find maxima & minima of functions and evaluate the integrals	2													
			2	Model and solve the relevant phenomena as a differential equation .	2													
			3	Demonstrate Fourier series and Analytic functions	2													
			4	Describe probability , Random Variables and Algebraic structures	2													
3	19BT1001	Biology for Engineers	1	Acquire the Knowledge of basic biology						2	2							
			2	Acquire the Knowledge of Human Biological Systems						2	2							
			3	Acquire Knowledge on Microorganisms and Biosensors						2	2							
4	20UC1102	Design Thinking and Innovation I	1	Understand the basics of design thinking and its implications in product or service development	2													
			2	Understand and Analyse the requirements of a typical problem		3												
			3	Plan the necessary activities towards solving the problem through ideation and prototyping				3	3						3			
			4	evaluate the solution and refine them based on the customer feedback			3						3					
5	20UC1203	Design Thinking and Innovation Ii	1	Understand the basics of design thinking and its implications in product or service development	2													
			2	Understand and Analyse the requirements of a typical problem		3												
			3	Plan the necessary activities towards solving the problem through ideation and prototyping				3	3						3			
			4	evaluate the solution and refine them based on the customer feedback			3						3					
SCIENCE ELECTIVE-1																		
1	19PH1008	Physics for Electronic Engineers	1	Ability to understand classification of solids based on their Energy Bands.	1						1							
			2	Ability to understand the conducting and semiconducting properties of solids at the microscopic level.	1						1							
			3	Ability to understand the dielectric properties of materials at the microscopic level and their applications.	1						1							

			4	Ability to understand the magnetic interactions in materials and the applications.	1						1							
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects							1							
2	19 PH1004	Solid State Physics	1	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	1						1							
			2	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering applications.	1						1							
			3	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	1						1							
			4	Understands the role of electronic energy band structures of solids using various models, classification of materials based on their band structures and their properties	1						1							
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	1						1							
3	19PH2101	Quantum Mechanics for Engineers	1	Understand the need of Quantum Mechanics and mathematical formulations of equations.	1													
			2	Understand the Wave function and its Physical properties.	1													
			3	Understand the applications of Quantum Mechanics for some semiconducting components.							2							
			4	Understand some simple Quantum Systems							2							
SCIENCE ELECTIVE-2																		
1	19CY1101	Engineerin g	1	Demonstrate different types of semiconducting materials	1		1										1	1
			2	llustrate photophysical basis of light absorption and emission by	1		1										1	1

		Chemistry		materials														
			3	Sketch the underlying principles of organic light emitting diodes					1		1						1	1
			4	Explain the concepts of solar cells modules and memory devices					1	1	1						1	1
			5	An ability to apply and generate experimental skills		1		1									1	1
2	19CY1002	Chemistry and Bio-Informatics for Engineers	1	Develop the current knowledge of materials and apply the characteristics, theories of materials in biomedical applications.	1				1	1							1	1
			2	Interpret the interaction of biomolecules with various bioelectrodes and host responses to implants, including toxicity and health implications	1				1	1							1	1
			3	Relate genetics and modern DNA technology for disease diagnostics, therapy and drug design.	1				1	1							1	1
			4	Illustrate the application of chemistry, organic electronics in diagnostic and therapeutic area.	1				1	1							1	1
			5	Analyse the properties of the samples using analytical instruments which are useful for clinical analysis in health care, drugs and pharmaceutical laboratories.	1		1			1							1	1
3	19CY1004	Organic Electronics	1	Demonstrate different types of semiconducting materials	1		1										1	1
			2	Illustrate photo physical basis of light absorption and emission by materials	1		1										1	1
			3	Sketch the underlying principles of organic light emitting diodes					1		1						1	1
			4	Explain the concepts of solar cells modules and memory devices	1				1	1	1						1	1
			5	An ability to apply and generate experimental skills		1		2									1	1
III	**ENGINEERING SCIENCES**																	
1	20SC1101	Computational Thinking for Design	1	Illustrate how problems are solved using computers and programming.	1	2										1		
			2	Illustrate and use Control Flow Statements in C.	1	2										1		
			3	Interpret & Illustrate user defined C functions and different operations on list of data.	1	2												

			4	Implement Linear Data Structures and compare them.				2										
			5	Apply the knowledge obtained by the course to solve real world problems.	1	2		2										
2	20SC1202	Data Structures	1	Apply measures of efficiency on algorithms and Analyse different Sorting Algorithms.	1	1											1	1
			2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	1			1									1	1
			3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.	1			1									1	1
			4	Analyse different representations, traversals, applications of Graphs and Heap organization.		1		1									1	1
			5	Develop and Evaluate common practical applications for linear and non-linear data structures.	1	1											1	1
3	20ME1103	Design Tools Workshop - I	1	Practice design thinking by developing artistic skills			2											
			2	Visualize and practice innovative design by final drafting using photogrammetric and model the design using prototyping technique				2										
			3	Apply the concept of AI & Data analytics & finalize the requirements to design his idea					2									
			4	Draft a report of his project from the initial stage & make a report which include scope, time and cost management of his project				2										
4	19SC1209	Design Tools Workshop - II	1	Practice the design ideology by artistic skill			2											
			2	Visualize the design ideology by using VR technology				2										
			3	Visualize the design ideology by incorporating VR technique					2									
			4	Visualize and present his design idea by applying AR technique				2										
5	20SC1203	Object Oriented Programming	1	Understand basic Concepts of OOP, fundamentals of java and apply the concepts of classes and objects through Java Language. Apply constructors, Overloading, parameter passing.			2		2									1
			2	Apply access control, Inheritance, Packages.			2		2									1
			3	Apply Interfaces, Exception Handling, multi- threading, I/o			2		2									1
			4	Apply collection framework and event driven programming.			2		2									1

			5	Apply object-oriented programming concepts to write programs and Analyses requirements and design to implement lab-based project with SDLC in a group of students.							1		1	1			1	
6	20EC1101	Digital Logic & Processors	1	Understand numerical and character representations in digital logic, number system, data codes and the corresponding 8design of arithmetic circuitry. Understanding Logic gates, Logic theorems, Boolean algebra and SOP/POS expressions.	2	2												
			2	Combinational systems design using standard gates and minimization methods	2	2											1	2
			3	Sequential systems: Design of counters using flip flops.	2	2											1	2
			4	Understanding PLA’s, PAL’s, FPGA’s and processors		2												2
			5	Analyzing and realization of Boolean functions, half adder, encoders, decoders, flip flops and counters.					1								1	2
7	19EC1202	Computer Organization & Architecture	1	Understand the functionality and design the CPU functional units - control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.	1	2												
			2	Understand, analyze and design main, cache and virtual memory organizations.	1	2												
			3	Understand, analyze and design different types of I/O transfer techniques.	1	2												
			4	Understand the design issues of RISC and CISC CPUs and the design issues of pipeline architectures.		2	1											
8	20EC1213	Design of Basic Electronics and Circuits	1	Understand the basic electronic components.	2												1	
			2	Understanding of junction diode, I-V characteristics and applications of diodes.	2												1	
			3	Understanding the design and working of power supply and regulators using zener diodes.	2												1	
			4	Understand the working of BJT and study of data sheets, analog and digital IC’s.					1									
9	20EC2111	Electronic System Design	1	Capable to understand the electronic system design process, analyze the heat management system and understand the soldering techniques.	2				2								2	

		Workshop	2	Able to understand PCB fabrication process, PCB artwork and various protection methods for electronic systems.	2		2		2		2						2	
			3	Able to understand Raspberry Pi microcontroller and its applications	2		2		2		2						2	
			4	Able to understand product making steps, the noise reduction designs in components & circuits, high frequency designs and CAD packages	2				2								2	
			5	Recognizing the software tool and PCB fabrication steps to implement an electronic system. Recognizing the software tool and Raspberry Pi microcontroller board to implement a few specific applications.											2			
10	20EC2214	IoT Workshop	1	Understand the fundamentals of IOT components	2		2										2	
			2	Study of sensors, actuators and networks for IOT applications	2		2										2	
			3	Analysis and design of electronic systems for IOT	2		2										2	
			4	Development of IOT applications			2											
11	20EC2112	IT Workshop	1	Understand the HTML coding				2										
			2	Understand the XML				2										
			3	Learning of web designing and hosting					2									
			4	Hands on app development using Android studio for mobile applications.					2									
IV	**PROFESSIONAL CORE COURSES**																	
1	19EC2103	Analog Electronic Circuit Design	1	Study of BJT's and Various application in Amplifiers	3		2											
			2	Understand various types of FET's, IC Types and analyze FET as an Amplifier	3		2											
			3	Understand the Linear & Non-linear application of Op-AMP and analyze active filters	3		2											
			4	Analysis of different types of oscillators, filter and regulators.	3		2											
			5	Design and Testing of Analog circuits for realistic applications					2									

2	19EC2104	Communication Signals & System Design	1	Ability to represent Analog signal(s) as mathematical function(s) and Manipulate them into more desirable function(s) by using the several available mathematical operations. Understand the three types of system representation. Ability to compute the response of the system for any given input and impulse-response function.	3					2							1	1
			2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	3		2										1	1
			3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	3	3						2					1	1
			4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain												2	1	1
3	19EC2105	Analog and Digital Communication	1	Analyse the linear and non linear modulation concepts	1													
			2	Explore the basic digital communication systems and principles	1		3											
			3	Learning various line coding procedures and signaling schemes to facilitate data communications.	1		3											
			4	Understand the concepts of multiple access and various types of networks.	1		3											
			5	Analysis and design of Modulation and Demodulation features of various Analog & Digital Communication Systems.					2									
4	20EC2106	Embedded Controllers & Embedded Systems Design	1	Understand the architecture and programming concepts of 8086 Microprocessor	1	2												
			2	Apply the Programming concepts of 8051 Microcontroller					1									
			3	Analyse the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers			3											
			4	Understand the basic concepts of CORTEX STM-32 microcontroller and RTOS		2												
			5	Analyze the applications of programming with 8051 and 8086 on hardware / software. Analyze the applications of programming with Arduino					1									
5	19EC2207	Electroma	1	Understanding the basics of EM fields and magnetic fields	3	1												

		gnetic Fields & Applications	2	Study of wave propagation in wave guides, coaxial cables and other materials.	1	1												
			3	Analysis and study of application s of EM waves	3	1												
			4	Analysis and study of advanced topics in EM wave applications	1	1												
6	19EC2208	Digital Signal Processing	1	Understand the Analysis of FFT & Wavelets	1	2												
			2	Explore and Design the Digital filters: Digital FIR		2												
			3	Analysis and Design the Digital filters: Digital IIR		2												
			4	Understand and apply multi-rate signal processing, interpolation and decimation concepts			3											
			5	Design and Analysis of LTI Systems and Filters			3											
7	20EC2209 A	Statistics, AI, ANN	1	Apply the conditional probability and discrete distributions to suitable real- world situations.	1	2												
			2	Apply queuing models for single and multi-server s with finite and infinite queue capacity to suitable real world problems.	1	3												
			3	Study of introduction and search methods		2	2											
			4	Study the basics of ANN, FFN and FBNN	3		2											
8	20EC2209	AI, ANN Tools & Applications	1	Understand the basics of Probability, statistics and its Applications.	2	2												
			2	To understand the applications and tools of AI	2	2												
			3	To understand the concepts of AI searching techniques and ANN models	2	2												
			4	To Implement AI and ANN Models for real time problems	2	2												
9	19EC2210	Data Networks and Protocols	1	Understand the fundamentals of networking and protocols	1													
			2	Understand the networking technologies	1													
			3	Understand the Access networks		2												
			4	Understand the concepts of modern networking		2												
			5	Analysis and study of concepts of networking.					1									
V	**FLEXI COURSES**																	

1	19EC3015	VLSI Design	1	To understand the VLSI fabrication process and to be able to interact with integrated circuit process engineers. To analysis the theory and CV characteristics of MOS transistor.	1	2												
			2	Circuit Analysis and Characteristics of different Inverters.	3	2												
			3	Circuit Characterization and Performance Estimation and design layouts of MOS logic circuits	1	1												
			4	Study of MOS circuit performance and testing principles	1	1												
			5	Logic and Fault Testing	1	1			1									
2	19EC3016	Wireless Communi cations	1	Understand cellular concept, frequency reuse and hand off strategies.	1	3												
			2	Evaluate and design wireless and cellular communication systems over a stochastic fading channel.			1	2	1									
			3	Evaluate Equalizers and diversity techniques in mobile receiver design			1	2	1									
			4	Analyze latest wireless technologies such as wireless systems and standards and OFDM systems	1	2												
			5	Various key technologies used in wireless communications and the impairments in the various wireless communications.	1	1	1	1	1	1								
3	19EC3017	RF System Design	1	Understand the Importance of RF Circuit Design, RF behavior of passive components, Compare Types of Transmission Lines and represent Equivalent Circuits	1	1												
			2	Understand and analyse he RF diode, BJT and FET characteristics, and modelling amplifier input and output impedance matching with Graphical AID/Tool for RF Design;		1	3											
			3	Analyze Stability Considerations and stabilization methods to design RF Amplifiers Using Small Signal Analysis		1	2											
			4	Analyze high frequency oscillator configuration and mixer designs.			2	2										
			5	Analysis and design of RF electronic circuits			2	3										
4	19EC3018	Biomedica l	1	Study of bio potential recording and different non electric parameter measurements in medical field.	1	2												

		Electronics & IOT for Healthcare	2	Understanding the medical instrumentation and role of electronics for medial reliability.	1	2												
			3	Study of IOT for Healthcare as a next generation boon for electronics with the study of different sensors	1	1												
			4	Understanding the application oriented approach in medical fields through IOT.		1		2										
			5	Design and development of IoT applications for health care			1		2									
5	19EC3019	Electronics Instruments & Automation	1	Understand the Fundamentals of Electronics instrumentation and Measurements	3	1												
			2	interpret Electronic Measuring Instruments:	1	1												
			3	Explore Control Systems & Automation.	1	1												
			4	Study and analysis of industrial automation Instantiating Industrial Automation.		1		1										
			5	Analysing Electronics Instruments			2											
6	19EC3020	System Engineering, Operation Research & Designing	1	Introduction to the concepts and techniques of system design	1	2												
			2	Understand the basic of operation research		2	2											
			3	Understand and application of design objectives, industry & market forces and product design strategies		2	2											
			4	Understand and analyze the product design goals, methodologies.			2	2										
7	19EC3021	Electrical Technologies & Solar Power Systems	1	Understand the basics of electrical technology	1	2												
			2	Study and understand of power generation, transmission and distribution.		1	2											
			3	Study of electrical grids, smart grids, IoT applications in smart grids and remote management		1	3											
			4	Analysis and study of solar photo voltaic cells, AI & ML in solar cells array and networks			2	2										
			5	Design and analysis of photo voltaic cells for power generation and implementation of AI & ML for the analysis of solar cell arrays.			2	2										
8	19EC3022	Advance	1	Understanding of basic search algorithms	1	1												

		Course IN Soft-Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)	2	Study and applications of ANN and deep learning		1	3											
			3	Application of various ML techniques of k-Means, kNN, SVM and GMM		1	2											
			4	Understand of various advance computing methods			2	2										
			5	Analysis and implementation of ML and genetic algorithm computing for various applications			2	3										
VI	**LIST OF PROFESSIONAL ELECTIVES**																	
ES S1	**Renewable energy & Smart cities**																	
1	20EC3051	Wireless sensor Networks & IOT Applications	1	Understanding of wireless sensor network technologies	3	1											2	2
			2	Study of BLE protocols in WSN security and power applications.	1	1											2	
			3	Study and application of IOT and WSN for smart cities/ villages.	1	1												2
			4	Study of various IoT application in various domains		1		1									2	
2	20EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	1	Understand the basics of solar photo-voltaic cell structure	3	1											2	2
			2	Study of basic physics and components of solar photo voltaic cells	1	1											2	
			3	Study and design of solar PV systems and testing	1	1												2
			4	Analysis and design of SPV arrays		1		1									2	
3	20EC3053	Electronic Systems for Renewable Energy & Smart Grid	1	Study of Renewable Energy and types with solar power and electronic power converters.	3	1											2	2
			2	Understanding the electronics system for renewable energy sources with different sensors and data management.	1	1											2	
			3	Understanding the design of smart grid sub system and circuits.	1	1												2
			4	Study of Smart grid to IOT applications with smart grid security,		1		1									2	

				communication and power system													
4	20EC3054	IOT Applications for Smart Cities	1	Understand the basics of smart cities/villages/living	3	1											2	2
			2	Study of systems for smart cities with case studies.	1	1											2	
			3	Analysis and design of smart grid sub-systems and circuits	1		1											2
			4	Study of advanced topics related to privacy, scaling and design considerations.	1	1											2	
5	20EC3055	Systems for Smart Cities & Smart Villages	1	Understanding the systems and smart systems with local requirements issues and solutions	1	1											2	2
			2	Study of System for smart villages with different modules of smart villages with privacy and security	1	1											2	
			3	Study of System for smart cities with different management modules of smart cities.	1	1												2
			4	Understanding the next generation needs for smart Systems and Smart Global System.	1	1											2	
ES S2	**VLSI**																	
1	20EC3061	Low Power VLSI	1	Understand the power dissipation in MOS structure	3	1											2	
			2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits	1	1	1										3	
			3	Apply low power techniques for various combinational circuits.	1	1	1											2
			4	Design and analysis of low power techniques for memories.	1	1											3	
2	20EC3062	Algorithms for VLSI Design Automation	1	Understanding of computational and automation tools	1										2		2	3
			2	Understanding of VLSI layout modeling		1											3	
			3	Understand and analysis of hardware models	1		1											2
			4	Analysis and understanding the FPGA technologies	1		1			1							3	
3	20EC3063	ASIC and FPGA Chip Design	1	Study and design of combinational and sequential circuits using PLDs and state machines.	3		1										2	
			2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.			1								3		3	
			3	To study PLD structures and design process. Study of different	1		1											2

				CPLD and FPGA architectures														
			4	To understand different physical process.			1								1		3	
4	20EC3064	VLSI Sub-system Design and Design for Testability	1	Understand the design flow and methodologies of VLSI sub-system	3		1										2	3
			2	Study of memory and array sub systems	1		1										3	
			3	Analysis of fault tolerant designs	1		1											2
			4	Design of testing of VLSI systems	1		1		1								3	
5	20EC3065	Semiconductor Memories & MEMS	1	Understanding the basics of non-volatile memories	3	1											2	
			2	Understanding of random access memories	1		1										3	
			3	Analysis and understanding memory fault modeling and testing	1		1											2
			4	Understand the basics of MEMS and applications	1		1										3	
6	20EC3066	Analog & Digital IC Applications	1	Understanding the basics of non-volatile memories	3		1										2	3
			2	Understanding of random access memories	1		1										2	
			3	Analysis and understanding memory fault modeling and testing	1	1	1											2
			4	Understand the basics of MEMS and applications	1	1	1										2	
ES S3	**AUTOMATION & ROBOTICS**																	
1	20EC3071	Control Systems & Introduction to Robotics	1	Understand the concepts of control systems	3	1											1	
			2	Analysis of control systems in time and frequency domains	1	1												1
			3	Understanding the basics of robotics	1	1												
			4	Analysis and understanding of kinetics, dynamics and control of robots.	1	1												
2	20EC3072	Autonomous Vehicles & Automotive Electronic	1	Understanding the basics of autonomous vehicles	3	1											1	
			2	Understand the principles of sensors and actuators	1	1												
			3	Analysis and understanding of automotive electronic systems	1	1											1	
			4	Study of various miscellaneous topics	1	1												

		s																
3	20EC3073	Advanced Robotics	1	Understanding the fundamentals of robotics	3	1											1	1
			2	Analysis and understanding the various parameters of robots	1	1												
			3	Analysis and understanding the mechanisms involved in various robots.	1	1											1	
			4	Analysis of various case studies and humanoid applications of robots	1	1												
4	20EC3074	Computer Vision & Applications	1	Understanding of the fundamental concepts related to multi-dimensional signal processing.	3	1											2	
			2	Understanding of the feature extraction, pattern analysis visual geometric modeling, stochastic optimization.	1	1												
			3	Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision.	1	1												2
			4	Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering.	1	1											2	
5	20EC3075	Human Machine Interface & Brain Machine Interface	1	Understand the Basic Idea of Human Machine Interactions, and its Goals	3	1												
			2	Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms	1	1											1	
			3	Understand the Basic Idea of Brain Machine Interactions, and brain waves	1	1											1	
			4	Apply an interactive design process and universal design principles to designing HCI/BMI systems	1	1												
6	20EC3076	Designing Automation Systems & Assistive Robotic Systems	1	Understand the block diagrams and design considerations of automation systems.	3													
			2	Study of home automation, industrial robots and robotic arms	1												1	
			3	Applications of robots for human safety.	1	1											1	
			4	Study and understanding the assistive robotic systems.	1	1												

ES S4	SIGNAL PROCESSING																	
1	20EC3081	Speech Signal Processing	1	Understand the basics of speech signal processing					1								2	
			2	Understand and applications of various transformation techniques for filter.		1												2
			3	Understand the concepts and methods of aliasing, auto correct and filtering.					1									
			4	Analysis and understand advance topics in speech signal processing.					1									
2	20EC3082	Digital Image Processing	1	Acquire the fundamental concepts of a digital image processing system			3											
			2	Identify and exploit analogies between the mathematical tools used for 1Dand 2D signal analysis and processing by analysing 2D signals in the frequency domain through the Fourier transform			1		1								2	2
			3	Design and implement with MATLAB algorithms such as restoration, segmentation, filtering, and de-noising which develops an appreciation for the image processing issues.			1		1									
			4	Design and implement with MATLAB algorithms such as image compression			1		1									
3	20EC3083	Biomedical Image Analysis	1	Fundamentals of Digital image	1	1												
			2	Image Enhancement in Spatial and Frequency domain	1	1											2	
			3	Image Segmentation and Compression	1	1												2
			4	Morphological Image Processing and Advanced Topics		1		1										
4	20EC3084	Statistical Signal Processing	1	Understand the Random variables and random processes	1	1												
			2	Explain the estimation theory and methods of estimation criteria.	1	1											2	
			3	Explain and analyze the estimation of signal and spectral analysis	1	1												2
			4	Explain the Kalman filters and Apply and evaluate Statistical signal processing concepts to various applications under transform domain.		1		1										
5	20EC3085	Adaptive Signal	1	Understand the Basic concepts related to adaptive systems	1	1												
			2	Understand the Searching performance surface-stability and rate of	1	1											2	

		Processing		convergence														
			3	Understand the concepts of Least mean square and its algorithms	1	1												
			4	To know the applications and know the adaptive modeling		1		1										2
6	20EC3086	Detection and Estimation of Signals	1	Understand the concepts of detection theory and binary decisions.	1	1											2	
			2	Understand the theory and properties of estimation theory.	1	1												
			3	Understand the state estimation using various techniques.		1		1										2
			4	Understand and application of statistical estimation of parameters.		1		1										
7	20EC3087	Biomedical Signal Analysis	1	Basics	1	1												
			2	Modalities, Signal Processing Methods	1	1											2	
			3	Modern Biomedical Technologies & Instruments	1	1											2	
			4	Advanced Applications		1	1											
ES S5	**RF AND MICROWAVE**																	
1	20EC3091	Microwave Engineering	1	Able to Differentiate different Microwave components	1	3											2	
			2	Able to Identify transformers and microwave resonators	1	2												2
			3	Understand the concept of design of different microwave filters	1	2												
			4	Analyse the applications of microwave and millimetric wave circuits		2	1											
2	20EC3092	Antenna Design & Wave Propagation	1	Able to identify the radiation fields and antenna fundamentals	1	3												
			2	Able to Identify different types of antennas and arrays	1	2											2	2
			3	Understand the concept of antenna measurements, design and testing.	1	2												
			4	Study of real-world applications of various antennas.					1									
3	20EC3093	Radar Engineering & Navigational Aids	1	Understand the essential principles of operation and design of simple radar systems and analysis of essential elements of Transmitters , Receivers and design of simple Radar Receiver	1													
			2	Understand various types of Radars	1	3											2	
			3	Understand the principles of various Radars systems used in			1											2

				different applications														
			4	Understand the basic concepts related to different systems and sensors for navigation.			1											
4	20EC3094	Modern Antennas, Millimeter Waves & Applications	1	Understand and analysis of modern antenna design	1													
			2	Understand the concepts of mm waves and meteorological applications.	1	3											2	
			3	Understand and analysis of mm wave circuits.			1											2
			4	Study of applications of modern antennas and mm wave radar.			1											
5	20EC3095	Electronic Warfare, EMI & EMC	1	Understand the basic concept of Electronic Warfare	1													
			2	Able to identify the different Jamming techniques and its methodologies		3	1										2	
			3	Understand the concept of design of EMC and components		2	1											
			4	Analyse, design and testing of EMI and EMC		2	1											2
ES S6	**DATA COMMUNICATION**																	
1	20EC4051	Information Theory & Coding	1	Understand the basic concepts of coding methodology	1	1	1	1	1								2	
			2	Understand and evaluate different communication channels.	1	1	1	1	1									2
			3	Analysis of various coding techniques	1	1	1	1	1									
			4	Analysis of various Error detection and correcting methods	1	1	1	1	1									
2	20EC4052	4G Wireless Technologies and Cellular Communication	1	Spreading Sequences and Multi user systems	1	1	1	1	1									
			2	Multi carrier Communication Systems	1	1	1	1	1								2	2
			3	MIMO systems – spatial multiplexing. Ultra Wideband Communications	1	1	1	1	1									
			4	Advanced cellular communications and Miscellaneous topics	1	1	1	1	1									
3	20EC4053	Satellite Communications	1	Introduction: Basic Concepts of Satellite Communications	1	1	1	1	1									
			2	Satellite Link Design	1	1	1	1	1								2	
			3	Multiple Access Techniques	1	1	1	1	1									2

			4	Satellite Navigation & Global Positioning System	1	1	1	1	1									
4	20EC4054	Optical Communication and Network	1	Understand the basic concepts of optical communication	1	1	1	1	1									
			2	Analyze different optical sources, materials and structures	1	1	1	1	1								2	
			3	Evaluate different optical network protocols	1	1	1	1	1									2
			4	Understand different optical networks	1	1	1	1	1									
5	20EC4055	Next Generation Wireless Technologies(WCDMA, GPRS, GSM, UMTS)	1	5G New Radio	1	1	1	1	1									
			2	Massive MIMO for 5G and Beyond 5G	1	1	1	1	1								2	
			3	Millimeter wave Communications	1	1	1	1	1									
			4	Vehicular Communications and other Advanced Topics	1	1	1	1	1									2
6	20EC4061	TCP/IP & Other Protocol Suite	1	Understand the evolution of different TCP/IP Protocol Suites, Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP and ARP	1	1											2	
			2	DHCP Theory of Operation, DHCP Architecture, , DHCP			1	1	1									2
			3	Auto-Configuration: Network Address Translation			1	1	1									
			4	TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM	1	1												
7	20EC4062	VoIP Systems & Broad Band Networks	1	Understand the basic concepts Internet Telephony	1	1												
			2	Able to Identify different VoIP Architecture and protocols			1	1	1								2	2
			3	Understand the concept of Broadband Services			1	1	1									
			4	Analysis of Optical Network and Multimedia concepts	1	1												
8	20EC4063	5G Mobile, Wireless	1	Understand the basic concepts 4G & 5G Technologies	1	1												
			2	Able to Identify different 5G Channels and Networking concepts			1	1	1								2	
			3	Understand the concept of 5G Evaluation and its Applications			1	1	1									2

		Technologies & IEEE 802 Standards	4	Analysis of various IEEE standards	1	1												
9	20EC4064	Cloud-Computing & Network Security	1	Understand the basics of Cloud Networking	1	1												
			2	Able to Identify different Topologies and Architecture standards			1	1	1								2	
			3	Understand the concept of Cloud-Computing and Security			1	1	1									2
			4	Analysis of various Network Security issues	1	1												
10	20EC4065	IP Multimedia Sub-System & Emerging Technologies (Cloud, IOT, NFV, SDN)	1	Understand the basic concepts IMS and its Architecture	1	1												
			2	Able to Identify different IMS Protocol Stacks and its Operation			1	1	1								2	
			3	Able to Identify different various IMS services			1	1	1									
			4	Analysis of various Emerging Tech. of IMS	1	1												2
ES S7	**BIO-MEDICAL INSTRUMENTATION**																	
1	20EC4071	Automated Vehicles & Avionics	1	Understand the basic components of Automotive Electronics	1	2											2	
			2	Understand the technology involved in autonomous vehicles	1	3												2
			3	Analyse the security and control issues	1	2												
			4	Study of applications of modern instruments in Avionics	1	2												
2	20EC4072	Calibrations and Designing Advanced Instruments	1	Understand the basics of instruments and calibration.	1	2												
			2	Study of generations of instruments.	1	3											2	2
			3	Understanding the calibration process, methods and certification.	1	2												
			4	Design of advanced instruments with precision, accuracy and safety.	1	2												
3	20EC4073	Biological	1	Understand the cyber physical systems and major constituents.	1	2												

		& Cyber-Physical Systems	2	Understand and study of various types of cyber physical systems.	1	3											2	
			3	Study of biological and silicon interfaces.	1	2												2
			4	Study of various case studies and miscellaneous topics.	1	2												
4	20EC4074	Electronic Instruments & Biomedical Applications	1	Understand the fundamentals of Electronic Instrumentation	1	2												
			2	Explore the Electronics Instruments and Buses [range of instruments and their connectivity in a rack-mount using different buses),	1	3											2	
			3	Interpret the basics of Biomedical Electronics,	1	2												2
			4	Applications of Bio-medical Electronics (Ex: IoT in healthcare, remote robotic controlled operations, tele-medicine, Medical Electronics Instruments etc.)		2		2										
5	20EC3072	Autonomous Vehicles & Automotive Electronics	1	Understanding the basics of autonomous vehicles	3	1												
			2	Understand the principles of sensors and actuators	1	1											2	
			3	Analysis and understanding of automotive electronic systems	1	1												
			4	Study of various miscellaneous topics	1	1												2
6	20EC3075	Human Machine Interface & Brain Machine Interface	1	Understand the Basic Idea of Human Machine Interactions, and its Goals	3	1												
			2	Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms	1	1											2	
			3	Understand the Basic Idea of Brain Machine Interactions, and brain waves	1	1												
			4	Apply an interactive design process and universal design principles to designing HCI/BMI systems	1	1		2										2

S.No	Course Code	Course Name	PO												PSO	
			1	2	3	4	5	6	7	8	9	10	11	12	1	2
I	**HUMANITIES & SOCIAL SCIENCES**															
1	20UC1101	Integrated Professional English									3	3				
2	20UC1202	English Proficiency								3	3			3		
3	20UC2103	Professional Communication Skills	2				2			3	3	3				
4	20UC2204	Corporate Communication Skills	2				3	3	3			3				
5	20UC3005	Aptitude Builder-I	1				2			3		3				
6	20UC3006	Aptitude Builder-II	1				2			3		3				
7	20UC0007	*Indian Heritage and Culture	1													
8	20UC0008	*Indian Constitution												3		
9	20UC0009	*Ecology & Environment						1						3		
10	20UC0010	*Universal Human Values & Professional Ethics (ONLINE)								3						
11	20UC0011	*Entrepreneurship								3						
*Note: * marked course are audit courses*																
II	**BASIC SCIENCES**															
1	20MT1101	Mathematics for Computing	3													
2	19MT2102	Mathematics for Engineers	2													
3	19BT1001	Biology for Engineers						3	3							
4	20SC1102	Design Thinking and Innovation-I	2		3	3	3				3		3			
5	20SC1203	Design Thinking and Innovation-II	2													
6	20SC2104	User Centric Design Techniques	2	3		3	3				3		3			
SCIENCE ELECTIVE-1																
1	19PH1008	Physics for Electronic Engineers	1						2							
2	19 PH1004	Solid State Physics	1						2							
3	19PH2101	Quantum Mechanics for Engineers	1						2							

SCIENCE ELECTIVE-2																
1	19CY1101	Engineering Chemistry	1	1	1	1	2	3	3						1	1
2	19CY1002	Chemistry and Bio-Informatics for Engineers	1		1		2	3							1	1
3	19CY1004	Organic Electronics	1		1	2	2	3	3						1	1
III	**ENGINEERING SCIENCES**															
1	20SC1101	Computational Thinking for Design	1	2		2								3	1	1
2	20SC1202	Data Structures & Algorithms	1	1		1									1	1
3	19ME1103	Design Tools Workshop - I			2	2	2									
4	19SC1209	Design Tools Workshop - II			2	2	2									
5	20SC1203	Object Oriented Programming			2		2		3		3	3				3
6	20EC1101	Digital Logic & Processors	2	2			1								1	3
7	19EC1202	Computer Organization & Architecture	1	2	1											
8	20EC1213	Design OF Basic Electronics and Circuits	2				1								1	
9	20EC2111	Electronic System Design Workshop	3		3		3		3				3		3	
10	20EC2214	IOT Design Workshop	2		2	2	2								2	
11	20EC2112	IT Workshop				2	2									
IV	**PROFESSIONAL CORE COURSES**															
1	19EC2103	Analog Electronic Circuit Design	3		2		2									
2	19EC2104	Communication Signals & System Design	3	3	2			3		2				2	1	1
3	19EC2105	Analog and Digital Communication	1		3		2									
4	20EC2106	Embedded Controllers & Embedded Systems Design	1	2	3		1									
5	19EC2207	Electromagnetic Fields & Applications	3	1												
6	19EC2208	Digital Signal Processing	1	2	3											
7	20EC2209A	Statistics, AI, ANN	3	3	2											
8	20EC2209	Introduction to AI, ANN Tools & Applications	2	2												
9	19EC2210	Data Networks and Protocols	1	2			1									

V	**FLEXI COURSES**															
1	19EC3015	VLSI Design	3	2			1									
2	19EC3016	Wireless Communications	1	3	1	2	1	1								
3	19EC3017	RF System Design	1	1	3	3										
4	19EC3018	Biomedical Electronics & IOT FOR Healthcare	1	2		2	2									
5	19EC3019	Electronics Instruments & Automation	3	1	2	1										
6	19EC3020	System Engineering, Operation Research & Designing	1	2	2	2										
7	19EC3021	Electrical Technologies & Solar Power Systems	1	2	2	2										
8	19EC3022	Advance Course in Soft-Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)	1	1	3	3										
VI	**LIST OF PROFESSIONAL ELECTIVES**															
ESS1	**Renewable energy & Smart cities**															
1	20EC3051	Wireless sensor Networks & IOT Applications	3	1		1									2	2
2	20EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	3	1		1									2	
3	20EC3053	Electronic Systems for Renewable Energy & Smart Grid	3	1		1									2	2
4	20EC3054	IOT Applications for Smart Cities	3	1	1										2	
5	20EC3055	Systems for Smart Cities & Smart Villages	1	1											2	
ESS2	**VLSI**															
1	20EC3061	Low Power VLSI	3	1	1										3	2
2	20EC3062	Algorithms for VLSI Design Automation	1	1	1								2		3	3
3	20EC3063	ASIC and FPGA Chip Design	3		1								3		3	2
4	20EC3064	VLSI Sub-system Design and Design for Testability	3		1		1						2		3	3
5	20EC3065	Semiconductor Memories & MEMS	3	1	1										2	2
6	20EC3066	Analog & Digital IC Applications	3	1	1										2	3
ESS3	**AUTOMATION & ROBOTICS**															
1	20EC3071	Control Systems & Introduction to Robotics	3	1											1	

2	20EC3072	Autonomous Vehicles & Automotive Electronics	3	1											1	
3	20EC3073	Advanced Robotics	3	1											1	1
4	20EC3074	Computer Vision & Applications	3	1											2	2
5	20EC3075	Human Machine Interface & Brain Machine Interface	3	1											1	
6	20EC3076	Designing Automation Systems & Assistive Robotic Systems	3	1											1	
ESS4	**SIGNAL PROCESSING**															
1	20EC3081	Speech Signal Processing		1			1								2	2
2	20EC3082	Digital Image Processing			3		1								2	2
3	20EC3083	Biomedical Image Analysis	1	1		1									2	2
4	20EC3084	Statistical Signal Processing	1	1											2	2
5	20EC3085	Adaptive Signal Processing	1	1		1									2	2
6	20EC3086	Detection and Estimation of Signals	1	1	1	1									2	2
ESS5	**RF, MICROWAVE & RADARS**															
1	20EC3091	Microwave Engineering	1	3	1		1								2	2
2	20EC3092	Antenna Design & Wave Propagation	1	3			1								2	2
3	20EC3093	Radar Engineering & Navigational Aids	1	3	1										2	2
4	20EC3094	Modern Antennas, Millimeter Waves & Applications	1	3	1										2	2
5	20EC3095	Electronic Warfare, EMI & EMC	1	3	1										2	2
ESS6	**DATA COMMUNICATION**															
1	20EC4051	Information Theory & Coding	1	1	1	1	1								2	2
2	20EC4052	4G Wireless Technologies and Cellular Communication	1	1	1	1	1								2	2
3	20EC4053	Satellite Communications	1	1	1	1	1								2	2
4	20EC4054	Optical Communication	1	1	1	1	1								2	2
5	20EC4055	Next Generation Wireless Technologies	1	1	1	1	1								2	2
6	20EC4061	TCP/IP & Other Protocol Suite	1	1	1	1	1								2	2
7	20EC4062	VoIP Systems & Broad Band Networks	1	1	1	1	1								2	2

8	20EC4063	5G Mobile, Wireless Technologies & IEEE 802 Standards	1	1	1	1	1								2	2
9	20EC4064	Cloud-Computing & Network Security	1	1	1	1	1								2	2
10	20EC4065	IP Multimedia Sub-System & Emerging Technologies (Cloud, IOT, NFV, SDN)	1	1	1	1	1								2	2
ESS7	**BIO-MEDICAL INSTRUMENTATION**															
1	20EC4081	Automated Vehicles & Avionics	1	3											2	2
2	20EC4082	Calibrations and Designing Advanced Instruments	1	3											2	2
3	20EC4083	Biological & Cyber-Physical Systems	1	3											2	2
4	20EC4084	Electronic Instruments & Biomedical Applications	1	3		2									2	2

HUMANITIES AND SOCIAL SCIENCES

20UC1101 – INTEGRATED PROFESSIONAL ENGLISH

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of grammar to improve communication, reading, and writing skills	PO10	2
CO2	Demonstrate required knowledge over Dos and Don‘ts of speakingin the corporate context. Demonstrate ability to face formal situations / interactions.	PO9	2
CO3	Understand the varieties of reading and comprehend the tone and style of the author. Skim and scan effectively and appreciate rhetorical devices	PO9	2
CO4	Apply the concepts of writing to draft corporate letters, emails, and memos	PO10	3

Course Objective:

- To express themselves in English with greater fluency, accuracy and confidence
- To communicate with others in practical, business-oriented situations
- To handle variety of business contexts, from negotiating, to using telephone, making presentation.

Syllabus:

COMPETENCY: 1

A) Basic Grammar - Countable and uncountable nouns, present simple and continuous, past simple and continuous – classroom practice – Understand and interpret Texts and work place situations B)Structural Pattern - Present continuous for future arrangements State verbs, Regular and irregular verbs, Voice, Modal verbs – Reporting on going tasks in the corporate world C)Descriptive and Qualitative Patterns: Adjectives and Adverbs classroom practice) Time Expressions, Comparatives and superlatives, Pronouns, Conditionals, Phrases and clauses (Including Relative)

COMPETENCY: 2

a) Formal contexts: Being a PA, describing changes in a company Taking orders over the phone
b) Listening & Speaking: Participate in conversation with proper contextual language markers and turn taking. Classroom practice - Presenting context, reason, problem – Case analysis (short).

c) Body Language: Dos and Don‘ts of one to one interaction, Telephone interaction Video/ web conferencing. Culture specific practices.

d) Work Etiquette- situation, ambience, team skills, time management and leadership ability.

COMPETENCY: 3

a) Understand and assimilate main ideas and specific details. (250-300 words text of moderate difficulty)

b) Read for general understanding, interpreting, factual or specific information, for grammatical accuracy and information transfer.

c) Understand the general meaning of corporate context and office correspondence.

d) Understand short reports of predictable nature.

COMPETENCY: 4

a) Internal Correspondence. Making notes on routine matters, such as, taking/ placing orders

b) Emails: Types of emails, salutations, vocabulary used in formal and informal (Including beginnings and endings)

c) Writing straight-forward, routine letters of factual nature

Reference Books:

1. Business Benchmark Book- Preliminary- 2nd edition Cambridge Press 2019.
2. Business Benchmark Book- Pre Intermediate to Intermediate- 2nd edition Cambridge Press 2019

Web Links:

1. https://www.cambridgeenglish.org/
2. https://learnenglish.britishcouncil.org,https://apps.apple.com/in/app/bec-from-cambridge/id1351207688https://play.google.com/store/apps/details?id=com.liqvid.bec

20UC1202 – ENGLISH PROFICIENCY

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Demonstrating different interpersonal skills for employability	PO 8	2
CO2	Distinguishing business essential skills	PO9	2
CO3	Classifying social media and corporate communication skills	PO 12	2
CO4	Applying analytical thinking skills	PO 12	3

Course Objective:

- To communicate with others in practical, business-oriented situations
- To express themselves in English with greater fluency, accuracy, and confidence
- To handle themselves in English in a variety of business contexts, from negotiating, to using the telephone, to making presentations, to socializing

Syllabus:

COMPETENCY 1:
Job description- Advice on job applications – getting the right job- importance of doing a job interview -Launching and promoting a new product-Persuasive and negotiation skills -Types of emails: giving information, making an enquiry, answering enquiries -Marketing Report
COMPETENCY 2:
Becoming an entrepreneur- buying a franchise- franchising start -up -presenting business idea-signaling parts of presentation - arranging business travel- business conferences and meetings-spending sales budget
COMPETENCY 3:
Social media and business- introducing company using social media- staff survey- survey report-off-shoring and outsourcing- customer satisfaction and loyalty- communication with customers-corresponding with customers- business across cultures
COMPETENCY 4:
Underlying assumptions, finding the conclusions, Argument strengthening, Argument weakening, finding the fallacies

Reference Books:

1. Business Benchmark Book- Upper Intermediate - 2nd edition Cambridge Press 2019.
2. Business Benchmark Book- Pre-Intermediate to Intermediate- 2nd edition Cambridge Press 2019.
3. Business Benchmark Book-Upper Intermediate: 2nd Edition Cambridge Press, 2019
4. Pillai, Sabina, et.al, Soft Skills and Employability Skills, New Delhi: CUP. 2018. Print.
5. Peterson, Reading Skill, New York: Peterson. 2007
6. Verbal and Non-Verbal Reasoning, R. S. Aggarwal, S Chand Publications.

7. R S Agarwal, S Chand, _A modern approach to Logical reasoning‘
8. GRE Barron‘s, Mc Graw Hills
9. Logical Reasoning, Edgar Thorpe, Pearson Publications

Web Links:

1. https://www.cambridgeenglish.org/
2. https://learnenglish.britishcouncil.org,
3. https://apps.apple.com/in/app/bec-from-cambridge/id1351207688
4. https://play.google.com/store/apps/details?id=com.liqvid.bec
5. https://www.cambridgeenglish.org/exams-and-tests/business-preliminary/exam-format/
6. https://www.cambridgeenglish.org/exams-and-tests/business-preliminary/preparation/
7. www.bbclearningenglish.com
8. www.indiabix.com
9. www.freshersworld.com
10. www.managementparadise.com
11. www.coolavenues.com
12. www.indiaedu.com/entrance-exams/cat.../books.html
13. www.mycatprep.com

20UC2103 – PROFESSIONAL COMMUNICATION SKILLS

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Developing critical and analytical reading skills	PO12	2
CO2	Discovering different interpersonal skills to develop people skills	PO12	2
CO3	To enhance the problem-solving skills of the students through the concepts of Simple Equations, Ratio, Proportion &Variation, Percentages, Profit & Loss, Averages, Allegations, Simple & Compound Interest.	PO5	2
CO4	Apply diagrammatic representation of the given data to find the possible outcomes in the topics of Deductions, Cubes, Venn Diagrams and Arrangements	PO2	2

Course Objective:

- To develop comprehending skills
- To discover core thinking skills for problem solving
- To interpret logical thinking skills for better thinking ability

Syllabus:

COMPETENCY-1: Verbal Ability

- Reading for Gist & Summarizing
- Reading for Information & Inference
- Critical Reading
- Analytical Reading
- Logical Reading

COMPETENCY-2: Critical Thinking Skills

- Core Thinking Skills
- Categories of Thinking
- Problem Solving
- Decision Making

COMPETENCY -3: Quantitative Aptitude:

- Simple Equations, Ratio
- Proportion &Variation
- Percentages
- Profit & Loss

- Averages
- Alligations
- Simple & Compound Interest

COMPETENCY -4: Reasoning

- Deductions
- Cubes
- Venn Diagrams
- Linear arrangements
- Circular arrangements
- Ordering and Sequencing
- Selections

Reference Books:

1. Soft Skills by Dr. Alex S CHAND Publications
2. Objective English by Showarick Thrope, Pearson
3. Quantitative Aptitude by R S Agarwal, S CHAND Publications.
4. Quantitative Aptitude by Abhijit Guha, Mc Graw Hills.
5. Verbal and Non-Verbal Reasoning, R. S. Aggarwal, Schand Publications.
6. R S Agarwal, S.Chand , _A modern approach to Logical reasoning‘ GL Barrons, McGraw Hills

Web References / MOOCs:

1. Online resource: cssklu.bolgspot.com
2. www.indiabix.com
3. www.freshersworld.com
4. www.managementparadise.com
5. www.coolavenues.com
6. www.indiaedu.com/entrance-exams/cat.../books.html
7. www.mycatprep.com

20UC2204 – CORPORATE COMMUNICATION SKILLS

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	To distinguish product and process and quote them in speaking and writing activities	PO12	2
CO2	To apply interpersonal skills	PO12	2
CO3	To enhance the problem-solving skills of the students through the concepts of Numbers, Time & Work, Time & Distance, Permutations & Combinations, Probability which will enable them to improve their problem solving abilities which in turn improve their programming skills.	PO 5	2
CO4	To apply known facts to find the unknowns in the topics Clocks, Calendars, Binary Logic. Identify the rule set by analyzing the given observations in the topics Series, Analogy, Odd Man, Coding-Decoding	PO2	2

Course Objective:

- To demonstrate speaking, and writing skills
- To apply interpersonal skills
- To develop logical thinking skills for better thinking ability

Syllabus:

COMPETENCY-1: Verbal Ability
Speaking from the script, Product & Process Description, Presenting Arguments, Paragraph writing.
COMPETENCY-2: Soft Skills
Goal Setting, Team Building, Leadership, Time Management, Managing Stress
COMPETENCY -3: Quantitative Aptitude:
Numbers, Time & Work, Time & Distance, Permutations & Combinations, Probability
COMPETENCY -4: Reasoning
Clocks, Calendars, Binary logic, Number and letter series, Number and letter analogy, Finding the odd man, Coding-Decoding, Direction sense

Reference Books:

1. Soft Skills by Dr. Alex S CHAND Publications
2. Objective English by Showarick Thrope, Pearson
3. Quantitative Aptitude by R S Agarwal, S CHAND Publications.
4. Quantitative Aptitude by Abhijit Guha, Mc Graw Hills.

5. Verbal and Non-Verbal Reasoning, R. S. Aggarwal, Schand Publications.
6. R S Agarwal, S.Chand , _A modern approach to Logical reasoning‘ GL Barrons, McGraw Hills.

Web References / MOOCs:

1. Online resource: cssklu.bolgspot.com
2. www.indiabix.com
3. www.freshersworld.com
4. www.managementparadise.com
5. www.coolavenues.com
6. www.indiaedu.com/entrance-exams/cat.../books.html
7. www.mycatprep.com

20UC3005 – APTITUDE BUILDER-I

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	To discuss and interpret English language skills necessary for placements	PO12	2
CO2	To demonstrate skills to get selected in interviews and retain job	PO12	2
CO3	To enhance the problem-solving skills of the students through the concepts of Mensuration, Quadratic Equations & Inequalities, Progressions, Logarithms, Data Interpretation, Data Sufficiency which will enable them to improve their problem-solving abilities which in turn improve their programming skills.	PO5	2
CO4	To apply deductive logic to solve questions in Connectives, Blood relations, Ranking and time sequence, Symbols and notations. Apply principles of reflection and rotation to solve picture puzzles.	PO2	2

Course Objective:

- To identify different components of verbal ability and interview skills
- To apply the skills acquired in the placement tests to succeed.
- To develop logical reasoning for better thinking ability

Syllabus:

COMPETENCY-1:

a) **Verbal Ability:** Sentence Completion, Idioms & Phrases, One Word Substitutes, Sentence Improvement, Sentence Equivalence, Analogies

b) **Life Skills:** Attitude for Success, Connecting with People, Employment Communication (CV & Interview), Workplace Etiquette

COMPETENCY-2:

a) **Attitude for Success:** Stimulus and Response, Choosing the Response, Determinisms, Changing the attitude for success, Proactive and reactive Attitude

b) **Connecting with People:** Empathy, Assertiveness, Saying what you want to say, Saying what you do not want to say – saying _No‘

COMPETENCY-3: Quantitative Aptitude

Mensuration, Quadratic Equations & Inequalities, Progressions, Logarithms, Data Interpretation,Data Sufficiency

COMPETENCY-4: Reasoning

Connectives, Blood relations, Ranking and time sequence, Symbols and notations, Non-verbal reasoning (Picture puzzles), Data sufficiency

Reference Books:

1. Soft Skills by Dr. Alex S CHAND Publications
2. Objective English by Showarick Thrope, Pearson
3. Quantitative Aptitude by R S Agarwal, S CHAND Publications.
4. Quantitative Aptitude by Abhijit Guha, Mc Graw Hills.
5. Verbal and Non-Verbal Reasoning, R. S. Aggarwal, Schand Publications.
6. R S Agarwal, S.Chand , ‗A modern approach to Logical reasoning' GL Barrons, McGraw Hills.

Web References / MOOCs:

1. Online resource: cssklu.bolgspot.com
2. www.indiabix.com
3. www.freshersworld.com
4. www.managementparadise.com
5. www.coolavenues.com
6. www.indiaedu.com/entrance-exams/cat.../books.html
7. www.mycatprep.com

20UC3006 – APTITUDE BUILDER-II

L-T-P-S : 0-0-4-0
Credits 2
Contact Hours 4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the strategies and techniques for conversations in different contexts. Analyze the different parameters and formats of written technical communication and apply in everyday work and life.	PO8, PO10	3
CO2	Analyze the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.	PO8, PO10	3
CO3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest	PO1, PO5	3
CO4	Analyze the series of numbers or letters to predict the next number in the series or to find the analogy. Analyze the data to find the codes in the process of encoding and decoding. Apply the given set of conditions to select a team from a group of members.	PO1	4

Course Objective:

- To identify different components of verbal ability and interview skills
- To apply the skills acquired in the placement tests to succeed.
- To develop logical reasoning for better thinking ability

Syllabus:

Critical Reading: Reading to Identify the Theme**,** Reading to Identify the Central Idea**;** Reading to Identify the Tone, Reading to Identify Writer's Attitude, Reading to Identify Parallel Ideas, Reading to Identify Logical Conclusions.

Writing Skills: Note- making and Note- taking, Report Writing.
Presentation Skills- Preparing for the Presentation, Audience Analysis, Processing Information, Ice-breakers, Quotations, Presentation Structure**,** Say what you want to say- Say it, Say what you have said to say**,** Preparing for Question Hour, Funnel Effect and How to Overcome it.

Trinity Guild Hall - Communication Skills - Graded Evaluation and Testing-1-8 grades

Quantitative Aptitude: Ratio and Proportion, Percentages, Profit and Loss, Simple Interest and Compound Interest

Reasoning: Number and Letter Series, Number and Letter Analogy, Coding and decoding, Odd man out. Selections

Reference Books:

1. Dr. Meenakshi Raman and Dr. SangeethaSarma: *Technical Communication*.Oxford University Press: Delhi.2016.

2. M. Ashraf Rizvi: *Effective Technical Communication.* New Delhi: McGraw Hill Education(India) Private Limited

20UC0007 – INDIAN HERITAGE AND CULTURE

L-T-P-S : 2-0-0-0
Credits : NIL
Contact Hours : 2 Pre-
requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	To familiarize with various aspects of the culture and heritage of India through ages.	PO1	1
CO2	To acquaint with the contributions of Indians in the areas of languages and literature, religion and philosophy	PO1	1
CO3	To understand the Social structure and the spread of Indian culture abroad	PO1	1
CO4	To know the development of Science and Technology in India through ages and to appreciate the contributions of some of the great Indian scientists	PO1	1

Syllabus:

Introduction-Concept of Culture-Culture and Civilization-General Characteristics of Indian Culture-Importance of Culture-Unity in Diversity

History and Culture through the Ages – Fundamental Unity of Harappan and Vedic Culture – Jainism and Buddhism-Mauryan Period-Post-Mauryan Period-Gupta Period-Pallavas and Cholas

Advent of Islam in India-Islam and Sufism-Islamic Art and Architecture-Bhakti Movement-Vijayanagar Period-Art and Architecture and Literature

Rise of the West and its impact on India-Social and Religious reformers in the 18th and 19th centuries-Press and growth of modern Indian literature-Rise of Indian Cinema-Indian Independence

Reference Books:

1. Facets of Indian Culture- Spectrum Publications
2. Ancient India: National Council of Educational Research and Training
3. Medieval India: Part I & Part II: National Council of Educational Research and Training.
4. Modern India: National Council of Educational Research and Training.
5. An Advance History of India: R.C. Majumdar, H.C. Raychaudhuri & KalikinkarDatt: Macmillan India Ltd.
6. The Wonder that was India : A.L.Bhasham

20UC0008 – INDIAN CONSTITUTION

L-T-P-S : 2-0-0-0
Credits : NIL
Contact Hours : 2 Pre-
requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	To understand Constitutional development after Independence	PO12	2
CO2	To learn the fundamental features of the Indian Constitution	PO12	2
CO3	To get a brief idea of the powers and functions of Union and State Governments	PO12	2
CO4	To understand the basics of working of Indian Judiciary and the Election Commission	PO12	2

Syllabus:

Making of the Constitution: A brief analysis of National Movement. Constitutional development with reference to Government of India Act-1909,1919,1935 and Indian Independence Act-1947. The Constituent Assembly of India.

Basic features of the Indian Constitution: the Preamble, Fundamental Rights, Directive Principles of State Policy – Fundamental Duties

Government of the Union : The Union Executive – the President and the Vice-President – The Council of Ministers and the Prime Minister – Powers and functions, The Union legislature – The Parliament – The LokSabha and the RajyaSabha, Composition, powers and functions – therole of the Speaker.

Government of the State: The Governor – the Council of Ministers and the Chief Minister – Powers and Functions, The State Legislature – composition, powers and functions.

The Indian Judicial System: the Supreme Court and the High Courts – composition, Jurisdiction and functions, Judicial review, Judicial activism, Independence of Judiciary In India.**Election Commission:** Role and Functioning, Chief Election Commissioner and Election Commissioners.

Reference Books:

1. Indian Polity‘ by Laxmikanth
2. Indian Administration‘ by SubhashKashyap
3. Indian Constitution‘ by D.D. Basu
4. Indian Administration‘ by Avasti and Avasti
5. Constitutional Law of India‘ by Seervai H.M.

20UC0009 – ECOLOGY AND ENVIRONMENT

L-T-P-S : 2-0-0-0
Credits : NIL
Contact Hours : 2
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the importance of Environmental education and conservation of natural resources.	PO6	1
CO2	Understand the importance of ecosystems and biodiversity.	PO12	1
CO3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	PO6	3
CO4	Understand the importance of Environmental education and conservation of natural resources.	PO6	1

Syllabus:

The Multidisciplinary nature of Environmental Studies, Natural Resources, Forest resources, Mining and its impact on environment

Water resources, Mineral resources, Energy resources, Land resources, Soil erosion, Ecosystems, Biodiversity and its Conservation Environnemental Pollution

Soil waste management, Electronic waste management, biomedical waste management Disaster management, Environmental Legislation Environmental Impact Assessment Process.

Text Books:

1. Anubha Kaushik, C.P.Kaushik, ―Environmental Studies‖, New Age International, (2007).
2. Benny Joseph, ―Environmental Studies‖, Tata McGraw-Hill companies, New Delhi, (2009).

20UC0010 – UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS

L-T-P-S : 2-0-0-0
Credits 2
Contact Hours 3
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and identify the basic aspiration of human beings	PO8	2
CO2	Envisage the roadmap to fulfill the basic aspiration of human beings.	PO8	4
CO3	Analyze the profession and his role in this existence.	PO8	4

Syllabus:

Introduction to Value Education: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - The Basic Human Aspirations, Right Understanding, Relationship and Physical Facilities, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.

Harmony in the Human Being: Understanding the Human Being as Co-existence of Self (‗I') and Body, Discriminating between the Needs of the Self and the Body, The Body as an Instrument of ‗I', Understand Harmony in the Self (‗I'), Harmony of the Self (‗I') with the Body,Program to Ensure Sanyam and Svasthya.

Harmony in the Family and Society: Harmony in the Family - the Basic Unit of Human Interaction, Values in Human-to-Human Relationships, ‗Trust' – the Foundational Value in Relationships, ‗Respect' – as the Right Evaluation, Understand Harmony in the Society, Vision for the Universal Human Order.

Harmony in the Nature (Existence): Understand Harmony in the Nature, Interconnectedness, Self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing ‗Existence is Co-existence' at All Levels, The Holistic Perception of Harmony in Existence.

Implications of the Right Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models - Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Books:

1. R R Gaur, R Sangal and G P Bagaria, ―A Foundation Course in Human Values and Professional Ethics‖, 1st Edition, Excel Books.

20UC0011 – ENTREPRENEURSHIP

L-T-P-S : 2-0-0-0
Credits 2
Contact Hours 3
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyze the business environment in order to identify business opportunities,	PO11, PO12	4
CO2	Identify the elements of success of entrepreneurial ventures	PO11, PO12	2
CO3	Consider the legal and financial conditions for starting a business venture	PO11, PO12	2
CO4	Evaluate the effectiveness of different entrepreneurial strategies	PO11, PO12	4

Syllabus:

Conceptual definition of entrepreneurs and entrepreneurship, Entrepreneurship in economic theory, Historical development of entrepreneurship, Entrepreneurial practice, The importance of small business, Entrepreneurial economy, Entrepreneurship and Economic Development, Type of Entrepreneurship, Entrepreneur and small business, Features and types of businesses and entrepreneurs, Sources of business ideas, The role of entrepreneurship in economic development, Terms of entrepreneurship, Innovation and entrepreneurship, Entrepreneurship and small business, The life cycle of a small company, Small business sector in Croatia, Forms of entrepreneurial organization, Sources of capital, Entrepreneurial process, Entrepreneurial strategies. Starting a new company, Buying an existing business, Franchising, Family business. Entrepreneurial project: an entrepreneurial venture and entrepreneurial development chain.

Text Books:

1. ―How to think like an Entrepreneur‖ by Philip Delves Broughton
2. ―Teaching Entrepreneurship: A Practice-Based Approach‖ by Heidi M. Neck

BASIC SCIENCES

20MT1101 –MATHEMATICS FOR COMPUTING

L-T-P-S : 2-2-0-2
Credits : 4.5
Contact hours 6
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course outcome	PO/PSO	BTL
CO1	Model a system of equations for real world applications in engineering, physical and biological sciences, computer science, finance, economics and solve them through matrix algebra	PO1	3
CO2	Model basic and computational techniques on discrete structures like relations, orders, functions & FSM, Lattices, and propositional &predicate logic	PO1	3
CO3	Model real world structures and their related applications using advanced discrete structures like graphs and trees.	PO1	3
CO4	Model the given Statistical data for real world applications in Engineering science, Economics and Management.	PO1	3
CO5	Demonstrate the Aptitude and Reasoning skills (Tests in skilling hours)	PO1	2

Syllabus:

Linear Algebra:
Matrix Algebra: Introduction, Types of Matrices, Rank of matrix, Solutions of linear, Equations by Gauss elimination and Gauss Seidel methods, Eigen values, Eigen vectors. Quadratic forms
Introduction to Discrete Structures & Discrete Computation:
Relations: Closures of relations. Orders, Equivalence Relations, Functions, Finite-State Machines
Lattices: Partial order relation, Hesse Diagrams, Properties of Lattices and applications.
Logic and Proofs: Propositional Logic, Rules of Inferences, Applications of Propositional, Propositional Equivalences, Predicates and Quantifiers, Predicate logic, Consequences, Introduction to proofs, Proof methods and strategy.
Counting Techniques: Permutations and Combinations Fibonacci series, Divide-and-Conquer Algorithms, Recursive definitions, Generating Functions. Solving Linear Recurrence Relations.
Advanced Discrete Structures & Computation:
Graphs & Trees: Terminology, Types of Graphs, Bipartite graphs, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path, Planar Graphs, Trees, Tree Traversal Applications of trees, spanning trees and Minimal spanning trees
Modeling Statistical data for real world applications:
Axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Correlation, Regression and Curve fitting.

Skilling: {Tests in skilling hours}

Arithmetic:

Foundations in Arithmetic: Numbers, Ratio, Proportion, Variation, Averages, Percentages, Profit & loss, Time & Distance, Time & Work.

Applications of Number theory: Fermat's theorem, Euclidean Algorithm. Geometry: Lines, Triangles, Quadrilaterals, Polygons, Practical applications of common solids, irregular solids and their application in various engineering problems.

Logic & Reasoning:

Sets and Venn diagrams Deductions, Logical Connectives, Linear and circular arrangements. Clocks, Calendars, Blood Relations, Cubes, Number and letter series, Coding and Decoding, Symbolic representations of given data, Binary Logic, Non-Verbal reasoning.

Textbooks:

1. John Bird, Basic Engineering Mathematics**,** Sixth edition, Taylor & Francis Ltd., 2017, UK.
2. Kenneth H Rosen, Discrete Mathematics and its Applications, Seventh edition, McGraw Hill, 2007, USA.
3. Linear Algebra and Its Applications, Gilbert Strang, Fourth Edition

Reference Books:

1. Advanced Engineering Mathematics 10th Edition, Erwin Kreyszig
2. R.E. Walpole, R.H. Myers, S.L. Myes, Keying Ye, Probability and Statistics for engineers and scientist, Ninth edition, Pearson publications, 2012, USA.
3. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Second edition, Prentice Hall India Pvt Ltd, 1986, India.
4. Tremblay J P and Manohar R, ―Discrete Mathematical Structures with Applications to Computer Science‖, First edition, Tata McGraw Hill, 1975, India.
5. R. S. Agarwal, A Modern Approach to Verbal and Non-verbal Reasoning, S Chand Publications, 2018, New Delhi, India.

19MT2102 – MATHEMATICS FOR ENGINEERS

Course code : 19MT2102
L-T-P-S : 2-1-0-0
Credits 2
Contact Hours 3
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply differential and integral calculus to find maxima & minima of functions, evaluate the integrals and solve the differential equations.	PO1	3
CO2	Demonstrate the Fourier series and Laplace transforms.	PO1	2
CO3	Describe probability, Random Variables	PO1	2
CO4	Explain complex variables, analytic functions and introduction to stochastic process and Algebraic structures.	PO1	2

Syllabus:

***(A) Calculus*:**
(a) Differential and Integral Calculus: Taylor‘s series for function of two variables, Maxima and Minima for functions of two variables, Evaluation of double and triple integrals, Change of order of Integration, Change of Variables, in polar, cylindrical and spherical coordinates.
(b) Vector Calculus: Scalar and vector point functions, Gradient, Directional Derivative, Divergence and Curl, Evaluation of line integrals , Introduction to Greens and Stoke‘s theorems and their applications.
(c) Ordinary Differential Equations: Solution of first order equations and their applications, Newton law of cooling, Growth and Decay, Solution of second and higher order Differential Equations.
(d) Partial Differential Equations: Formation of PDE, Solution of first order linear equations – Lagrange‘s method, solution of second order PDE by separation of variables. Laplace‘s equation in two dimensions.

(B)Introduction to Advanced Matrix Algebra: Decomposition, Complex Matrices

(C) Laplace Transforms: Laplace and Inverse Laplace transforms and their properties.

(D) Fourier Series: Definition, Dirchelt conditions, Fourier series for simple functions.

(E) Complex Variables: Complex functions- Exponential, Logarithmic and Trigonometric functions, Analytic function, Cauchy - Riemann equations, Introduction to Milne Thomson method .

(F) Probability and Random Variables: Probability , Addition, Multiplication and Baye's theorems. Random variables, Probability Distributions – Binomial, Poisson and Gaussian distributions, Introduction to Markov process.

(G) Algebraic Structures: Introduction to Structure of Algebras, Semi groups, Monoids and Groups, Homomorphism's, Normal subgroups and congruence Relations, Rings**.**

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Willey & Sons, 10th edition,2010, New Delhi, India.

Reference Books:

1. R.E.Walpole, R.H.Myers, S.L.Myes, Keying Ye, Probability and Statistics for Engineers and Scientists, , Pearson's Publications , 9th edition, 2012, USA.
2. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists andMathematicians, Prentice Hall of India Private Ltd, 1986, India.
3. Tremblay J P and Manohar R, Discrete Mathematical Structures with Applications toComputer Science, Tata McGraw Hill publishers, 1st edition, 2001, India.

20UC1102 - DESIGN THINKING AND INNOVATION-I

L-T-P-S : 1-0-0-4
Credits 2
Contact Hours 5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of design thinking and its implications in product or service development	PO1	2
CO2	Understand and Analyze the requirements of a typical problem	PO2	4
CO3	Plan the necessary activities towards solving the problem through ideation and prototyping	PO4, PO5, PO11	4
CO4	evaluate the solution and refine them based on the customer feedback	PO3, PO9	5

Syllabus:

Overview of Design Thinking: Define Design Thinking, Differentiate Design Thinking fromDesign, Get an Overview of the Design Thinking Process.
Empathize and Understand: Explain how empathy influences the outcomes of Design Thinking, List Different Empathy Research Techniques, Define the Guidelines for an EmpatheticResearch,
Defining Needs: Explain how PoV can be used in defining the design problem, Use a structured approach to arrive at a PoV,
Ideation for Solutions: List the best practices for conducting a successful ideating session, Describe the techniques for evaluating and prioritizing ideas, **Prototyping**: Define prototyping, Explain how prototyping aids in communicating ideas effectively, List various tools for prototyping,
Testing the Solution: Define the steps of a successful testing approach, Demonstrate the processof gathering and responding to user feedback.

Text Books:

1. Design Thinking for Innovation: Research and Practice – Walter Brenner and FalkUebernickel
2. Different Thinking: Creative Strategies for developing the innovative business 01 – PeterKreuz and Anja Foerster
3. Design Thinking: Integrating Innovation, Customer Experience and Brand Value –Thomas Lockwood
4. Building Smart Cities: Analytics, ICT, and Design Thinking – Carol L. Stimmel

Reference Books:

1. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products,Services, Businesses and Ecosystems

20UC1203 - DESIGN THINKING AND INNOVATION-II

L-T-P-S : 1-0-0-4
Credits 2
Contact Hours 5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of design thinking and its implications in product or service development	PO1	2
CO2	Understand and Analyse the requirements of a typical problem	PO2	4
CO3	Plan the necessary activities towards solving the problem through ideation and prototyping	PO4, PO5, PO11	4
CO4	evaluate the solution and refine them based on the customer feedback	PO3, PO9	5

Syllabus:

Design Thinking for Problem Solving Mindset : Understanding Problem Statements, Recapping Design Principles, Design Thinking Toolsets, Formulating approaches to Solutions, Applications of Design Thinking: Case Study

Designing Services : Functional requirements, User requirements, Designing for sustainability and resilience, Case study

Designing Thinking for Space and Environment : Functional requirements, user requirements, Implementing Design Thinking Framework, Case study

Design Thinking and Innovation Management Culture : How design thinking leads to innovative thinking, Business model thinking, How design Thinking can lead to next generation customer experience, Metrics for successful implementation of Design Thinking

Intellectual property and protection of ideas : Concepts of copyright, Intellectual Property, Trademark, Service mark Patent and typical business benefits, Applying for patent, Product license agreement, Open-source license, Need for protecting own R&D innovations, Enhancing brand image with IP

Reference Books:

1. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products,Services, Businesses and Ecosystems

19BT1001 – BIOLOGY FOR ENGINEERS

L-T-P-S : 2-0-0-0
Credits :2
Contact Hours :2
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Acquire the Knowledge of basic biology	PO6, PO7	2
CO2	Acquire the Knowledge of Human Biological Systems	PO6, PO7	2
CO3	Acquire Knowledge on Microorganisms and Biosensors	PO6, PO7	2

Syllabus:

Basic Biology: Introduction, Living organisms, Cell structure and Organelles, Organogenesis,Human Anatomy.

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking andcoordination and Defense,

Diet and Nutrition: Macro (Carbohydrates, proteins, lipids) - and Micronutrients (vitamins),
Essential minerals and their role; deficiency symptoms; and their role; deficiency symptoms. **Micro-organisms:** Classification of Microorganisms, beneficial and harmful effectsof Bacteria, Fungi and Viruses.

Biosensors, biomechanics and Medical Imaging technology, Applications of Biosensor in Foodand Agriculture.

Text Books:

1. Dr RC Dubey ,‖Advanced Biotechnology‖, S Chand Publications.
2. P K Gupta ,‖Elements of Biotechnology‖, RASTOGI Publications.

19PH1008 - PHYSICS FOR ELECTRONIC ENGINEERING

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Ability to understand classification of solids based on their Energy Bands.	PO1	2
CO2	Ability to understand the conducting and semiconducting properties of solids at the microscopic level.	PO1, PO7	4
CO3	Ability to understand the dielectric properties of materials at the microscopic level and their applications.	PO1, PO7	5
CO4	Ability to understand the magnetic interactions in materials and the applications.	PO1, PO7	5
CO5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects	PO7	3

Syllabus:

Crystal structure: Types of bonds, Force vs inter atomic distance curve, PE curve, Crystal Structures and defects, Energy bands in solids, Classification of electronic materials: metals, semiconductors and insulators.

Electrical properties: Free electron model, Conductivity in metals and Concepts of Fermi level, effective mass and holes, Concept of phonons, Thermoelectricity, Intrinsic and extrinsic semiconductors, Fermi level variation by carrier concentration and temperature, p-n junction, Diffusion and drift transport, carrier life time and diffusion length; Direct and indirect band gaps, Optical transitions, photon absorption, photovoltaic effect.

Dielectrics: Dielectrics and electrical polarization, Depolarization field, Clausius-Mossotti relation; Drude model, Electronic polarization and its mechanisms, Dielectric breakdown; Piezoelectricity, Pyroelectricity and Ferroelectricity, optical properties.

Magnetism in materials – types of interactions, Magnetic susceptibility, Curie and Neel temperatures; Domains, Magnetic anisotropies, Spin-orbit interaction, spintronics

Text Books:

1. Kasap, S.O. Principles of Electronic Materials and Devices. McGraw-Hill, 3/e. ISBN-10: 0073104647.

Reference Books:

1. Hummel Rodolf, Electronic Properties of Materials, *ISBN* 0-387-98303-1.
2. Kittel. C, Solid State Physics, Wiley student 8th edition, *ISBN*: 978-0-471-41526-8

19PH1004 - SOLID STATE PHYSICS

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	PO1	2
CO2	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering applications.	PO1, PO7	4
CO3	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	PO1, PO7	5
CO4	Understands the role of electronic energy band structures of solids using various models, classification of materials based on their band structures and their properties	PO1, PO7	5
CO5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	PO1, PO7	3

Syllabus:

Magnetic properties: Origin of Magnetic Moment, Dia, Para, Ferro, Anti-ferro and Ferri Magnetism, Domain theory and Hysteresis Effect of Ferro and Ferri Magnetism, Soft and Hard Magnetic Materials.

Thermal properties: Iron-Carbon Diagram, Heat capacity, Thermal Expansion and Thermal Conductivity in Metals, Ceramics and Polymers, Heat treatment of Materials, Hardening, Tempering, Quenching and Nitriding.

Mechanical Properties: Stress, Strain, Hooke's Law, Elasticity, Plasticity, Creep, Ductility, Brittle, Hardness, Strength, Modulus of Elasticity, Fracture, Fatigue, Stress-Strain Behaviour of Ductile and Brittle Materials, Hardness Tests- Vickers, Rockwell and Brinell.

Electrical Properties: Energy band theory, Band structures in Conductors, Semi conductors and Insulators, Electrical properties of conductors- Ohms, Mathiessen rule, conductivity, Mobility, Electrical properties of Semi conductors, Factors effecting the carrier concentration, Conductivity and Mobility of charge carriers. Electric properties of Insulator-Dielectrics- Types of Dielectrics, Dielectric Constant, Polarization, Types of Polarizations, Frequency Dependence of Polarization, Ferro, Piezo Electrics.

Optical properties: Optical reflectance, Optical Absorption, Snell's law, Total Internal reflection in optical fibers.

Introduction to Solids and Semiconductors:

Free electron theory of metals, Fermi level, density of states in 1,2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Kronig-Penny model and origin of energy bands. Types of electronic materials: metals, semiconductors, and insulators, Intrinsic and extrinsic semiconductors, Dependance of Fermi level on carrier concentration and temperature (equilibrium characteristics), Carrier generation and recombination, Carrier transport, diffusion and drift, p-n junction..

Text Books:

1. Callister. William D., Jr. "Materials Science and Engineering: An Introduction" 6th edition, 2007, Wiley India Pvt.Ltd.ISBN-10: 0471135763.
2. Kittel.Charles, "Introduction to Solid State Physics" 8th edition, 2012, Wiley India Pvt.Ltd.ISBN: 978-0-471-41526-8.

Reference Books:

1. Dekker.Adrianus J. "*Solid State Physics"*1st Edition *2002,* Macmillan India Ltd.ISBN 10: 0333918339.
2. Pillai.S. O., "Solid state physics" Revised 6th edition, New Age International Publishers. ISBN: 9781906574109.
3. Rangwala, Engineering Materials (Material Science)**,** Charotar Publishing House PVT. LTD.ISBN-10: 9380358261.

19PH2101 - QUANTUM MECHANICS FOR ENGINEERS

L-T-P-S : 3-1-0-0
Credits :4
Contact Hours :4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the need of Quantum Mechanics and mathematical formulations of equations.	PO1	2
CO2	Understand the Wave function and its Physical properties.	PO1	2
CO3	Understand the applications of Quantum Mechanics for some semiconducting components.	PO1	2
CO4	Understand some simple Quantum Systems	PO1	2

Syllabus:

Introduction and Review: Inadequacy of classical physics, Quantum postulates, radiation, Photoelectric effect, Compton effect, de Broglie's Wave-particle duality; Heisenberg uncertainty relations; Wave function and its interpretation, Schrodinger's equation, time dependent and independent

equation, stationary states. Wave Function and Physical Properties: Probability density and probability current, equation of continuity; Wave function as a vector, physical variables as operators; Eigen values,

eigen functions, expectation values and uncertainties. Particle in One-dimension: Infinite square well, finite potential well, GaAs quantum well between AlGaAs layers in a semiconductor heterostructure, triangular well, application to electron in a MOSFET. Quantum Tunnelling: Potential barrier, tunnelling, tunnelling probability; Double rectangular barrier, resonant tunnelling, Esaki tunnel diode; Barrier of arbitrary shape. Simple Quantum Systems: Harmonic oscillator, energy levels and wave functions, quantum picture of the LC-circuit; Centrally symmetric potentials angular momentum and spin, hydrogen electron, energies, and orbitals.

Text Books:

1. Quantum Mechanics: An Introduction for Device Physicists and Electrical Engineers, Second Edition, David K Ferry, Institute of Physics Publishing 2001.
2. Fundamental Quantum Mechanics for Engineers, Leon van Dommelen, 15 Jun 2012 Version 5.55 alpha.

Reference Books:

1. Introduction to Quantum Mechanics, David J.Grifiths.
2. Quantum Mechanics, Leonard I. Schiff

Web Links:

1. http://dsc.discovery.com/tv-shows/curiosity/topics/10-ways-quantum-physicswill-change-world.htm
2. http://dsc.discovery.com/tv-shows/curiosity/topics/10-real-world-applicationsof-quantum- mechanics.htm

19CY1101 – ENGINEERING CHEMISTRY

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Predict potential complications from combining various chemicals or metals in an engineering setting	PO1, PO3, PO7	2
CO2	Discuss fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena	PO1, PO3	2
CO3	Examine water quality and select appropriate purification technique for intended problem	PO1, PO7	2
CO4	Explain the role of chemical kinetics in the formation and destruction of ozone in the atmosphere and predict the connection between molecular behavior and observable physical properties.	PO1, PO7	2
CO5	An ability to analyze and generate experimental skills	PO1, PO4, PO7	3

Syllabus:

Electrochemistry: Single electrode potential and its measurement, Electrochemical cells, EMF series, Nernst equation, Cell emf measurement, Reversible and irreversible cells, Concentration cells, Reference electrodes Determination of pH using glass electrode. Gas Sensors: Capacitance Manometer and Mass Spectrometer. Batteries: Chemistry, construction and engineering aspects of Primary (mercury battery) and secondary (lead-Acid cell, Ni-Metal hydride cell, Lithium cells) and fuel cells– Hydrogen–Oxygen fuel cell, advantages of fuel cell; Energy and Chemistry: Energy Use and the World Economy, Defining Energy, Energy Transformation and Conservation of Energy, Heat Capacity and Calorimetry. Enthalpy, Hess's Law and Heats of Reaction, Energy and Stoichiometry. CORROSION & ITS
CONTROL: Causes and different types of corrosion and effects of corrosion. Theories of corrosion– Chemical,
Electrochemical corrosion, Pitting corrosion, stress corrosion, Galvanic corrosion. Factors affecting corrosion– Nature of metal, galvanic series, over voltage, purity of metal, nature of oxide film, nature of corrosion product. Nature of environment- effect of temperature, effect of pH, Humidity, effect of oxidant. Cathodic protection, sacrificial anode, impressed current cathode, electroplating: WATER Technology: Introduction, Hardness: Causes, expression of hardness – units – types of hardness, estimation of temporary and permanent hardness of water, numerical problems. Alkalinity and estimation of alkalinity of water, numerical problems. Boiler troubles – Scale & sludge formation, caustic embrittlement, Boiler corrosion, priming & foaming. Softening of water: Internal and external treatments -Lime soda, Ion exchange process. Desalination-reverse osmosis and electro dialysis: Chemical Kinetics: Ozone Depletion, Rates of Chemical Reactions, Rate Laws and the Concentration Dependence of Rates, Integrated Rate Laws, Temperature and Kinetics, Reaction Mechanisms, Catalysis, insight into Troposphere Ozone. Molecules and Materials: polymers- Types of polymerization-Mechanisms, Plastics – Thermoplastic

resins and thermosetting resins - Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde. Conducting Polymers:

Polyacetylene, polyaniline, conduction, doping and applications. Carbon nano tubes and Applications.

Text Books:

1. Engineering Chemistry, Jain & Jain, Dhanpat Rai Publishing Company. New Delhi.
2. Engineering Chemistry, O G Palanna, The Tata McGraw Hill, New Delhi.

Reference Books:

1. Chemistry in Engineering and Technology, Volume 2, J C Kuriacose & J Rajaram, Tata McGraw Hill, New Delhi.
2. Chemistry for Engineers Rajesh Agnihotri, Wiley, New Delhi.
3. Engineering Chemistry, B. Sivasankar, The Tata McGraw Hill, New Delhi.
4. A text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co. New Delhi.
5. Engineering Chemistry, C Parameswara Murthy, C V Agarwal and Andra Naidu, B S Publications, Hyderabad.
6. Engineering Chemistry, Shikha Agarwal, Cambridge University Press.

Web Links:

1. http://www.chem1.com/acad/webtext/elchem/
2. https://nptel.ac.in/downloads/122101001/3
3. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/polymers.htm

19CY1101 –CHEMISTRY AND BIOINFORMATICS OF ENGINEERS

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Develop the current knowledge of materials and apply the characteristics, theories of materials in biomedical applications.	PO1, PO5, PO6	3
CO2	Interpret the interaction of biomolecules with various bioelectrodes and host responses to implants, including toxicity and health implications	PO1, PO5, PO6	3
CO3	Relate genetics and modern DNA technology for disease diagnostics, therapy and drug design.	PO1, PO5, PO6	3
CO4	Illustrate the application of chemistry, organic electronics in diagnostic and therapeutic area.	PO1, PO5, PO6	3
CO5	Analyse the properties of the samples using analytical instruments which are useful for clinical analysis in health care, drugs and pharmaceutical laboratories.	PO1, PO3, PO6	3

Syllabus:

Biomaterials and Semiconductors

Introduction to Biomaterials - classification of Biomaterials – polymers - Polymerization – conducting polymers- types – mechanism – applications. Ceramics – Introduction – types- applications. (3hours)

Nanomaterials- Introduction- classification- synthesis- mechanism- properties- applications (3 hours)

Semiconductors- organic and inorganic semiconductors – electrochemistry of organic electronic materials – dye sensitized solar cells – organic light emitting diodes – quantum dot LEDs - concept of exciton. (4 hours)

Biomolecules and Biosensors

Concepts of Biomolecules- Amino acids, peptides and proteins – primary, secondary, tertiary and quaternary structures of proteins – enzymes and catalysis – coenzymes – nucleotides and nucleosides – nucleic acids (DNA and RNA) – double helical structure of DNA. (4 hours)

Concepts of Biopotential- Bioelectrodes- Biosensors- Advantages- limitations and various components of biosensors- Transducers in biosensors- colorimetric- optical- amperometric- piezoelectric- Introduction to actuators- Examples. (6 hours)

Genes and Drug Design

Tools for identifying genes – overview of sequence annotation – gene prediction methods – human variation and disease identification – visualizing. Structure spectra correlations - chemical reactions and synthesis design - drug design - Prediction of physical and chemical properties- elements of bioinformatics and genomics. (10 hours)

Biomedical Instruments and Applications

Introduction to biomedical instrumentation- Classification- Measuring instruments (Blood pH meter- Blood flow meter)- Recording Instruments (Ultra sonograph- Radiograph- Tomography)- Analyzing Instruments (colorimeter- spectrometer- flame photometer)- NMR- MRI- Point of care devices- lab on chip- Bioimaging- Applications- Organic bioelectronics. (10 hours)

Text Books:

1. Biomaterials: Multidisciplinary approaches and their related applications, White falcon Publishing, 2020
2. Nanotechnology- An Introduction to synthesis, properties and Applications of Nanomaterials, Atlantic Publishers and Distributors, 2011
3. Polymer Science and Technology, Joel R Fried, 3rd Edition, Pearson Publications
4. Organic Chemistry- Volume 2: Stereo chemistry and the Chemistry of Natural Products, 5th Edition, I. L. Finar
5. Biomedical Instrumentation by Dr. M. Arumugam, First Edition, Anuradha Publications

Reference Books:

1. Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InterScience (1989) 3rd ed.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.
3. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd ed.

Web Links:

1. https://nptel.ac.in/courses/113/104/113104009/
2. https://nptel.ac.in/courses/102/106/102106057/
3. https://nptel.ac.in/courses/104/103/104103121/
4. https://nptel.ac.in/courses/102/106/102106070/

19CY1004 –ORGANIC ELECTRONICS

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Demonstrate different types of semiconducting materials	PO3,PSO1, PSO2,PO1	2
CO2	Illustrate photophysical basis of light absorption and emission by materials	PSO1,PSO 2,PO1,PO3	2
CO3	Sketch the underlying principles of organic light emitting diodes	PO7,PSO1, PSO2,PO5	3
CO4	Explain the concepts of solar cells modules and memory devices	PSO1,PSO 2,PO5,PO6, PO7	3
CO5	An ability to apply and generate experimental skills	PO2,PO4,P SO1,PSO2	3

Syllabus :

Introduction to organic electronics: Semiconductors – difference between organic and inorganic semiconductor – direct and indirect band gap materials – charge transport in organic semiconductors – electrochemistry of organic electronic materials – dye sensitized solar cells – organic light emitting diodes thin film transistors – capacitors. Optical properties of organic molecules: Electromagnetic spectrum – theory of light absorption – excited state – singlet and triplet states – intersystem crossing and internal conversion – Jablonski diagram – UV visible, fluorescence and phosphorescence – energy transfer processes- organic lasers and memory devices. Organic light emitting diodes: Theory of light emission – concept of exciton– inorganic and organic light emitting diodes – Frenkel and Mott excitons – internal and external quantum efficiency – top and bottom emitting devices – active and passive matrix devices – working mechanism of OLEDS - white light emitting diodes – light emitting electrochemical cells – quantum dot LEDs – polymer light emitting diodes – device degradation and efficiency roll-off. Organic photovoltaics and thin-film transistors: operation theory of solar cells– inorganic and organic photovoltaics – carrier generation in organic solar cells – bulk-heterojunction, inverted and tandem solar cell devices – Working mechanism - hybrid perovskite solar cells – top and bottom contact organic thin film transistors – display driver circuits – device degradation mechanism and efficiency roll- off – printed photovoltaics and thin film transistors – organic bioelectronics - Materials for MEMS.

Text Books :

1. Material science and engineering: an introduction, Callister and Rethwisch, 9th Ed.
2. Engineering chemistry, Jain and Jain 3. Organic Electronics Materials and Devices; Shuichiro Ogawa, 2015

ENGINEERING SCIENCES

20ME1103 –DESIGN TOOL WORKSHOP-I

L-T-P-S : 0-0-4-0
Credits :2
Contact Hours :4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Practice design thinking by developing artistic skills, Visualize and complete his/her innovative design by final drafting using 3D modeling	PO3	2
CO2	Understand the concept of web page, web browser, web server, and able to create Static webpages. Apply the HTML5 and CSS knowledge in building static web pages. Introduction to building social profiles through web blogging and video blogging.	PO5	3
CO3	Understand the concept of report writing using a markup language Latex. Build reports using Latex and apply templates and Bibliography in latex for various documentation purposes.	PO5	3
CO4	Understand the concept of data visualization and apply visualization techniques in creating data visualization dashboards with tools like Power BI, Understand the basic concept of VR/AR and apply them to build projects from neighborhood for social causes.	PO5	3
CO5	Practice design thinking by developing artistic skills, Visualize and complete his/her innovative design by final drafting using 3D modeling	PO3	2

Syllabus:

Introduction to Design thinking, Preparing the minds for innovation, 360 Prototype idea generation and a case study

3D Modeling: - Conceptual Design, 2D Sketches to 3D Solid Model, Assembly modeling using AUTODESK FUSION 360.

HTML: Introduction to web browser and URL, Introduction to HTML, Creating a simple HTML page, HTML documents, Concept of tags, Basic structure of HTML document, Head, Body, Paragraph creation, line breaks, text, list, tables, Hyperlinks and images.

HTML5: Basic of HTML5, Special features of HTML5, Canvas, audio, video, Geo location, drag and drop.

CSS: Concept of CSS, Need of CSS, Creating style sheet, CSS properties, CSS styling (Background, text, format, controlling fonts), Styling with lists and tables, CSS Ids and class, CSS color, Creating page layouts and site design. Introducing students to social profile building through web and video blogging.

Data Visualization: Introduction to data visualization, Data, types, Importance of data visualization, Different tools for visualization and comparisons in brief. Excel data explanation, Creation of column Chart, stacked bar chart and Heat map, Creation of excel dashboard. Creation of Dashboards in Power BI. Creation of bar charts, date tables and pie charts in Power BI, creating slicers and maps in power BI. Applying data visualization for story telling in social use cases.

Latex Report Writing: Understanding Latex compilation, Basic syntax, Writing equations, Tables, Figures handling, List of figures, List of tables, Generating index. Applications: Writing resume, Writing project reports.
Virtual Reality & Augmented Reality: Introduction to Virtual reality, Virtual 360 Environments, Creating basic 360 Virtual frame. Introduction to Augmented reality, Different types of AR, Platforms to create AR interfaces. Build AR/VR applications for Social use cases from neighborhood.

Text Books:

1. "Complete Design Thinking Guide for Successful Professionals" by Daniel Ling
2. "Rapid Prototyping: Principles and Applications by Chua C.K., Leong and Lim. C.S, 2nd Edition, World Scientific.
3. Learn HTML & CSS by John Duckett.
4. HTML5 and CSS3 All-in-One for Dummies
5. Mastering Microsoft Power BI *Expert techniques for effective data analytics and business intelligence by Brett Powell*
6. LaTeX Tutorials: A Primer by Indian TeX Users Group by Indian TeX Users Group (https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf)

Web Links:

1. https://www.coursera.org/learn/3d-model-creation-fusion-360
2. https://www.coursera.org/learn/html/home/welcome
3. https://www.udemy.com/course/become-a-good-latex-user-to-create-professional-documents/

19SC1209 –DESIGN TOOL WORKSHOP-II

L-T-P-S : 0-0-4-0
Credits :2
Contact Hours :4
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Practice the design ideology by artistic skill	PO3	2
CO2	Visualize the design ideology by using VR technology	PO4	3
CO3	Visualize the design ideology by incorporating VR technique	PO5	3
CO4	Visualize and present his design idea by applying AR technique	PO4	3

Syllabus:

Design Thinking in Modern Art & Ideas: Modern Art & Ideas, Transforming everyday objects, Abstract painting, clay modeling, poetry and literary.
Virtual Reality: Hardware and History, VR Applications, Psychology of VR: the three illusions, challenges in virtual reality, Future of Embodiment in VR, Realism, Graphics, Real-Time 3D Graphics in Games, Basic Concepts in 3D Computer Graphics, Realism Animation, Navigation, Nausea.
Room Scale VR, Holography, Mirror Reality: Setting up room scale VR, Simulation of virtual environment, Stereoscopic Vision, Perspective, Interference and Diffraction, Laser Viewable Holograms, Real and Virtual Images, Introduction to mirror reality.
Augmented Reality: Augmented Reality, characteristics of AR systems and main components of an AR architecture, Augmented Reality with Geolocation,Customizing an augmented reality game.

Text Books:

1. "Complete Design Thinking Guide for Successful Professionals" by Daniel Ling
2. "Project Management" by K. Nagarajan, 7th Edition, New Age International Publishers.
3. "Augmented Reality and Virtual reality" by Timothy Jung, M.ClaudiaTomDieck, Springer.
4. "Rapid Prototyping: Principles and Applications"by Chua C.K., Leong and Lim. C.S, 2nd Edition, World Scientific.
5. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, 3rd Edition, Prentice Hall.

Web References:

1. https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
2. https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
3. https://www.coursera.org/learn/modern-art-ideas?

20SC1202 –DATA STRUCTURES AND ALGORITHMS

L-T-P-S : 3-0-2-4
Credits :5
Contact Hours :9
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply measures of efficiency on algorithms and Analyse different Sorting Algorithms.	PO1, PO2, PSO1, PSO2	4
CO2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	PO1, PO4, PSO1, PSO2	4
CO3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.	PO1, PO4, PSO1, PSO2	4
CO4	Analyse different representations, traversals, applications of Graphs and Heap organization.	PO2, PO4, PSO1, PSO2	4
CO5	Develop and Evaluate common practical applications for linear and non-linear data structures.	PO1, PO2, PSO1, PSO2	5

Syllabus:

Algorithm Analysis: Mathematical Background, Model, Analyse, Running Time Calculations, Lists.
Stacks and Queues: Abstract Data Types (ADTs), The List ADT, The Stack ADT, The Queue ADT.
Trees: Preliminaries, Binary Trees, The Search Tree ADT—Binary Search Trees, AVL Trees, Splay Trees, Tree Traversals (Revisited), B-Trees, Red black trees
Hashing: General Idea, Hash Function, Separate Chaining, Hash Tables without Linked Lists, Rehashing, Hash Tables in the Standard Library, Extendible Hashing.
Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Applications of Priority Queues. **Sorting:** Preliminaries, Insertion Sort, A Lower Bound for Simple Sorting Algorithms, Shell sort, Heap sort, Merge sort, Quick sort, Indirect Sorting, A General Lower Bound for Sorting, Bucket Sort, External Sorting.
Graph Algorithms: Definitions, Topological Sort, Shortest-Path Algorithms, Minimum Spanning Tree.

Text Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2010, Second Edition, Pearson Education.
2. Ellis Horowitz, Fundamentals of Data Structures in C: Second Edition, 2015

Reference Books:

1. A.V.Aho, J. E. Hopcroft, and J. D. Ullman, “Data Structures and Algorithms”, Pearson Education, First Edition Reprint 2003.
2. Horowitz, Sahni, Anderson Freed, “Fundamentals of data structures in C”, Second Edition-2007.
3. R. F. Gilberg, B. A. Forouzan, “Data Structures”, Second Edition, Thomson India Edition, 2005.

4. Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, "Data Structures & Program Design in C", Fourth Edition-2007.

List of Lab Experiments:

1. Develop a set of programs to implement Linear and Binary searching techniques (both iterative and recursive)
2. Develop a set of programs to find the solution for the maximum subsequence sum problem with different time complexity solutions.
3. Develop a set of programs to implement below sorting techniques
    a. Insertion Sort
    b. Shell sort
    c. Selection Sort
4. Develop a set of programs to implement below sorting techniques (Divide and conquer method)
    a. Quick sort with median of three.
    b. Merge Sort
5. Develop a Program to implement operations of doubly linked list
    a. Create
    b. Insert
    c. Display
    d. Delete
    e. Search
6. Develop a program to perform operation on stack using linked list
7. Develop a program to perform operations on queue using linked list
8. Develop a program to implement Circular Queue using Array
9. Develop a program to implement Binary Search Tree with Traversal Operations
10. Develop a program to perform following operations on AVL tree
    a. Insertion
    b. Deletion
11. Develop a program to implement the following
    a. Separate chaining for collision handling
    b. Open Addressing Technique
12. Develop a program to implement Heap sort
13. Develop a program to implement
    a. Breadth First Search
    b. Depth First Search
    c. Dijkstra's Algorithm
14. Program to implement Minimal Spanning by
    a. Prim's algorithm
    b. Kruskal's algorithm

20SC1203 –OBJECT ORIENTED PROGRAMMING

L-T-P-S : 2-0-4-0
Credits :4
Contact Hours :6
Pre-requisite : NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand basic Concepts of OOP, fundamentals of java and apply the concepts of classes and objects through Java Language. Apply constructors, Overloading, parameter passing.	PO3, PO5, PSO2	3
CO2	Apply access control, Inheritance, Packages.	PO3, PO5, PSO2	3
CO3	Apply Interfaces, Exception Handling, multi- threading, I/o.	PO3, PO5, PSO2	3
CO4	Apply collection framework and event driven programming.	PO3, PO5, PSO2	3
CO5	Apply object-oriented programming concepts to write programs and Analyses requirements and design to implement lab-based project with SDLC in a group of students.	PO7, PO9, PO10, PSO1	4

Syllabus:

Introduction: Object-Oriented Programming, OOP Principles, Encapsulation, Inheritance and Polymorphism Java as a OOPs & Internet Enabled language, The Byte code, Data types, Variables, Dynamic initialization, scope and life time of variables, Arrays, Operators, Control statements, Type Conversion and Casting, Compiling and running of simple Java program.
Classes and Objects: Concepts of classes and objects, Declaring objects, Assigning Object Reference Variables, Methods, Constructors, Access Control, Garbage Collection, Usage of static with data and methods, usage of final with data,
Overloading methods and constructors, parameter passing - call by value, recursion, Nested classes.
Inheritance: Inheritance Basics, member access rules, Usage of super key word, forms of inheritance, Method Overriding, Abstract classes, Dynamic method dispatch, Using final with inheritance, String handling functions.
Packages and Interfaces: Packages, Class path, Importing packages, differences between classes and interfaces, Implementing & Applying interface.
Exception Handling: Exception Handling fundamentals, Collections Framework.

Text Books:

1. Herbert Schildt, "The Complete Reference Java", 7th edition TMH.
2. Timothy A. Budd, "An Introduction to Object-Oriented Programming", 3/e, Pearson, 2008.

Reference Books:

1. Deitel&Deitel, "'Java – How to program", 6th edition, PHI, 2007

2. Cay.S.Horstmann and Gary Cornell “Core Java 2, Vol 1, Fundamentals”, Seventh Edition, Pearson Education.

List of Lab Experiments:

1. Every student must complete minimum 12 experiments and one Lab based Project.
2. Java program to implement nested if
3. Java program to generate a multiplication table using for- loop
4. Java program to find out second largest number
5. Java program on array – bubble sort
6. Java program on constructor over loading
7. Java program on method overloading
8. Java program on inheritance and method overriding
9. Java program on access specifiers
10. Java program on packages
11. Java program with two interfaces
12. Java program on exception handling
13. java programs on collection Frame work-1
14. java programs on collection Frame work-2

20EC1101 – Digital Logic & Processors

L-T-P-S : 3-0-2-0 Credits : 4
Pre-requisites : NIL Contact Hours : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand numerical and character representations in digital logic, number system, data codes and the corresponding 8design of arithmetic circuitry. Understanding Logic gates, Logic theorems, Boolean algebra and SOP/POS expressions.	**1,2**	**1,2**
CO2	Combinational systems design using standard gates and minimization methods	**1,2**	**3**
CO3	Sequential systems: Design of counters using flip flops.	**1,2**	**3**
CO4	Understanding PLA's, PAL's, FPGA's and processors	**2**	**1**
CO5	Analyzing and realization of Boolean functions, half adder, encoders, decoders, flip flops and counters.	**5**	**3**

Gist: Number system, conversion, Combination Logic, Sequential Logic, PLD, Intro to Processor, ALU, Instruction Register, Instruction Decoder.

Syllabus:

Basics of Logic Design: Number systems: Binary, Octal and Hexa decimal; Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Karnaugh map, Digital waveform characteristics; Codes: BCD, ASCII, Parity and Alphanumeric; Code Conversion, Logic Gates TTL and CMOS ICs, IC Data sheet parameters, Clock Buffer (7440) and level shifter (CD 4504).

Combinational Logic design: Half Adder/Subtractor (7486, 7408 and 7404); Full adder using 7483, Full Subtractor using simple gates, Decoders (74HC238,74LS154), Encoders(CD4532,74184), Multiplexers/Demultiplexers (4051, 4052, 4053), Magnitude Comparators (4585 , 7485), Parity Generators and Checkers (74180), BCD to seven segment decoder (74LS47), Verilog HDL design for Combinational Logic Functions.

Sequential Logic design: NAND/NOR Latches Gated Latches (4011/4001), JK (7476/4027) and D Flip-flops (7474/4013), Shift registers (SISO, SIPO, PISO,PIPO), Design of Synchronous counters (7476, 7490, 7493) and Asynchronous Counters (4013), Up-down counters (74193/CD4510),Ring and Johnson counters, Digital Clock design, Verilog HDL design for Sequential Logic Functions.

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Logic implementation using Programmable Devices. Introduction to Complex Programmable Logic Devices and Field Programmable Gate Arrays, Applications of CPLDs and FPGAs. **Processors:** Block diagram of generic processors, ALU, Instruction register, Instruction decoder, execution of micro instructions (Adding two HEXA Numbers).

Text Books:

1. Digital Principles and Logic Design by ArijitSaha and Nilotpal Manna ISBN: 978-1-934015-03-2 Jones & Bartlett Publishers 2007

2. M. Morris Mano, “Digital Logic and Computer Design”, Pearson.

Web References:

1. https://onlinecourses.nptel.ac.in/
2. https://onlinecourses.nptel.ac.in/noc18_ee33/previe
3. https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view
4. https://www.youtube.com/watch?v=qqeRUgAvmzQ
5. https://www.youtube.com/watch?v=o1-hj6GKaFY
6. https://www.youtube.com/watch?v=2gI3aC5blfA

List of Experiments:

1. Realization of Boolean Function using Logic Gates

2. Realization of Half Adder/Subtractor (7486, 7408 and 7404), Full adder using 7483, Full Subtractor using simple gates & Decoders (74HC238, 74LS154).

3. Realization of Priority Encoding using CD 4532 and BCD / Binary decoder 74184)

4. Implementation of Multiplexers / Demultiplexers (4051, 4052, 4053)

5. Implementation of BCD to Seven Segment decoder (74LS47)

6. Realization of Decade Counter Using JK Flip flop (7476 and 4027)

7. Implementation of Up down counter with LED display using 74193

8. Analysis of BCD to Excess 3 & Binary to Gray Codes.

9. Summing & Subtractor of ALU Using discrete IC’s

20EC1213 – Design of Basic Electronic Circuits

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 2

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic electronic components.	**1**	**1**
CO2	Understanding of junction diode, I-V characteristics and applications of diodes.	**1**	**1**
CO3	Understanding the design and working of power supply and regulators using zener diodes.	**1**	**1**
CO4	Understand the working of BJT and study of data sheets, analog and digital IC's.	**5**	**1**

Gist: Diodes & Transistors, Regulators & Power supply circuit, Thevenin & Norton Theorem.

Syllabus: BASIC ELECTRONIC COMPONENTS:
Introduction to Electronic Components: Components, types of components, color coding, types of resistors, types of capacitors, types of inductors, switches, diodes, transistors, Induction coils, transformers.
Introduction to Circuit Theory: Mesh analysis, Nodal Analysis, Thevenin's theorem, Norton's theorem, Super position theorem, Maximum power transfer theorem.

Diodes: P-type and N-type semiconductors (brief discussion), P-N junction, forward bias and reverse bias, V-I characteristics, ideal and practical diodes, approximate model, diode data sheet, types of diodes and variants (Introductory level only).
Applications of diodes: Clippers, Clampers, Rectifiers - HWR, FWR, BR with and without capacitive filters.
POWER SUPPLY & TRANSISTER BASICS:
Power supply: Power supply with ripple reduction and regulation.
Zener Diode: Difference between ordinary diode and zener diode, zener diode as a voltage regulator, Avalanche and Zener breakdown, Zener characteristics, Applications.
BJTs: Types of transistors (PNP and NPN), switching transistors, power transistors (low, medium and large power), key parameter from data sheet. (Gain, Bandwidth, β,α...etc.
Analog & Digital ICs: 7805,7905,IC 741, IC 555, LM 339, LM723.
Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell

Reference Books

1 Integrated Electronics by Millman & Halkias

20EC2111 –Electronic System Design Workshop

L-T-P-S : 1-0-2-2 Credits : 2.5

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Capable to understand the electronic system design process, analyze the heat management system and understand the soldering techniques.	**1,5**	**2**
CO2	Able to understand PCB fabrication process, PCB artwork and various protection methods for electronic systems.	**1,3,5,7**	**2**
CO3	Able to understand Raspberry Pi microcontroller and its applications	**1,3,5,7**	**4**
CO4	Able to understand product making steps, the noise reduction designs in components & circuits, high frequency designs and CAD packages	**1,5**	**2**
CO5	Recognizing the software tool and PCB fabrication steps to implement an electronic system. Recognizing the software tool and Raspberry Pi microcontroller board to implement a few specific applications.	**11**	**4**

Gist: PCB Design, Fabrication, Raspberry-Pi Boards, Embedded Circuits Application Design hands-on

Syllabus:

(a) Design Process and Its Fundamentals; Product Life Cycle, Electrical/RF safety; Technical Drawings, Circuit Diagrams; Electronic Systems and Classifications: Examples and case studies;

(b) Heat Management and Cooling by using Heat Sinks, Soldering Techniques.

(a)PCB Making: PCB Artwork using PC software, Design and of Multilayer PCBs, SMDs and mounting techniques.

(b)Protection: Grounding, Shielding; Balancing and Filtering; EMI / EMC/ ESD Protections; Cabling and Connectors; Panel Layout Ergonomics.

(a) Introduction to Raspberry Pi microcontroller board

(b) Developing applications using Raspberry Pi microcontroller board

(a)Electronic System Design implementations analog, digital (TTL/ CMOS) and Microcontroller systems; Opto isolators, Relays and Displays, A to D and D to A converters, RAM Data Storage and retrieval, Data Generators

(b)Applications and Product making

Testing, Packaging, manufacturing, recycling and Environmental Compliance, Design for: Low noise, EMI/EMC compatibility, High frequency designs, PTH, CAD Packages

Text Books

1 Fundamentals of Electronic Systems Design by Jens Lienig, Hans Bruemmer ISBN 978-3-319-55839-4 ISBN 978-3-319-55840-0 (eBook), © Springer International Publishing AG 2017
2 Learning the Art of Electronics – A hands-on lab course Thomas C Hayes with the assistance of Paul Horowitz
3 Electronic Instrument Design, 1st edition; by: Kim R.Fowler; Publisher: Oxford University Press, 2015.
4 ELECTRONICS- A systems Approach 4th Edition by Neil Storey ISBN: 978-0-273-71918
5 PRINTED CIRCUIT BOARDS - Design, Fabrication, Assembly and Testing by Dr R S Khandpur
6 Raspberry Pi Cookbook by Simon Monk, Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.
7 Noise reduction techniques in electronic systems by Henry W Ott

Reference Books

1 Printed Circuit Boards - Design & Technology, 1st edition; by: Walter Bosshart; Tata McGraw Hill
2 David a. Bell electronic devices and circuits 5th edition.
3 Karl. T. Ulrich, Steven D. Eppinger, " Product design & development", Mc Graw Hill Companier 5th edition
4 Electronic Product Design, R.G.Kaduskar, V.B.Baru, Wiley India 2nd edition

Web References

1 https://www.youtube.com/watch?v=tWnfnt2rNO0
2 https://www.youtube.com/watch?v=cVhSCEPINpM
3 https://www.youtube.com/watch?v=mv7Y0A9YeUc

S. No. List of Experiments

1 Introduction to PCB Layout design for any small project
2 PCB Design artwork using PCB Wizard(for an electronic circuit such as comparator)
3 Etching and Drilling after artwork of the PCB designed
4 Soldering, wiring and testing of an electronic circuit on PCB designed and made
5 Interfacing Raspberry Pi with Switch relay and Light control
6 Interfacing Raspberry Pi with DC motor to control a linear motor/fan
7 Interfacing Raspberry Pi with IR sensor to detect obstacle or make a line following robot
8 Interfacing Raspberry Pi with Ultrasonic sensor(SR04) to measure distance to the obstacle or enhance the line following robot
9 Interfacing Raspberry Pi with LCD to display the distance measured using Ultrasonic sensor(SR04)
10 Interfacing Raspberry Pi with alcohol sensor(MQ135) with ADC

S. No. Mini projects
1 Smart industrial automation using IoT(Bluetooth, Relays, Android app)
2 Greenhouse monitoring system(upload the data to cloud)
3 Electronic Eye security system(PIR sensor, Magnetic sensor and Fire sensor, LM339)

20EC2112 – IT Workshop

Course code : 20EC2112 L-T-P-S : 1-0-2-0
Pre-Requisite: NIL Credits: 2

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Experiment with architectural design of a computer with various basic concepts of operating systems and provides solution to PC Hardware and Software problems	PO2, PO3	3
CO2	Identify the basic peripherals and assemble the PC with OS installation	PO3, PO4	3
CO3	Construct connection for the PC on to the internet from home and workplace with effective usage of the internet, Usage of web browsers, email, newsgroups and discussion forums.	PO3, PO5	3
CO4	Experiment with cases designed using office tools and latex	PO6	3

SYLLABUS:
PC Hardware – Software – OS Installation - Troubleshooting - Internet and World Wide Web – Web Browsers – Search Engines – Develop Home Page - Software Productivity Tools – Ms Word – Mail Merge - Spreadsheet Orientation – Microsoft Excel – Powerpoint - Latex – Project – News Letter – Documentation

TEXT BOOKS:
1. IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfinson and Ken Quamme. – CISCO Press, Pearson Education.
2. Microsoft Office Word by TorbenLageFrandsen, Ventus Publishing ABS, 2010
3. Latex Begineer's Guide by Stefan Kottwiz, Packt Publishing, 2011

REFERENCE BOOKS:
1. LaTeX Companion – Leslie Lamport, PHI/Pearson.
2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
3. Comdex Information Technology course tool kit Vikas Gupta, WILEY Dreamtech
4. PC Hardware and A+ Handbook – Kate J. Chase PHI (Microsoft)

WEB REFERNCES/MOOCS:
https://www.classcentral.com/course/edx-cs50-s-introduction-to-computer-science-442

20EC2214 –IOT Design Workshop

Course code : 20EC2214 L-T-P-S : 1-0-0-4
Pre-Requisite: NIL Credits: 2

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding and Designing IOT applications with NODE MCU and Arduino.	**1,2**	**1,2**
CO2	Study of Raspberry Pi with different communication module to design IOT applications	**1,2**	**3**
CO3	Designing of Web Page, control and analyze sensor data through it	**1,2**	**3**
CO4	Understanding the inbuilt protocols and IOT management with STM 32.	**2,4**	**3**

Syllabus:

IoT Applications & Sensors: Analog & Digital sensors, MPU 6050, MCP2515(CAN), DS2321 (RTC), Applications Interfacing to IoT : Micro controllers boards, ESP8266, Peripherals (Motors, Camera, Speaker, Displays), Controlling through Mobile & Web

IoT Data Communication: Wi-Fi Protocols, Bluetooth, BLE, WSN, Zigbee, RFID, NFC, Client Server, Cloud. Protocols & Case Studies : Issues & Challenges : Security, Privacy, Scalability, Store and Analytics Case Studies: Health, Smart cities, Village/ Agriculture

Text Books

1 Internet of Things a hands-on Approach by Arshdeep behga and Vijay madisetti ,Orient Black Swan Publications.

Web References

1 https://www.eventshigh.com/detail/chennai/33e6f1710a75921963a8e81f394c4f5b-internet-of-things-iot-workshop
2 https://www.skyfilabs.com/iot-courses-and-workshops
3 https://www.youtube.com/watch?v=SiU-QZwik8w
4 https://www.youtube.com/watch?v=p82vmuJqu-8
5 https://www.youtube.com/watch?v=bOsjfixX_lk
6 https://www.youtube.com/watch?v=9ev3xTDEhtw

19EC2113 Basic Electronic Circuits

Course code : 19EC2113 L-T-P-S : 3-0-0-0
Pre-Requisite: NIL Credits: 3

COURSE OUTCOMES (COs):

CO No	**Course Outcome (CO)**	**PO/PSO**	**(BTL)**
CO1	Understand the passive circuit elements and working.	PO1,5/ PSO1	2
CO2	Understand the basic circuit analysis techniques	PO1,5/ PSO1	3

CO3	Understand the active circuit elements and working.	PO1,5/ PSO1	2
CO4	Understand the applications of semiconductor devices	PO1,5/ PSO1	3

SYLLABUS:

Basic passive Circuits elements: Types of elements- Resistor, Inductor, Capacitor, energy sources and their properties, Ohm's Law.

Circuit Analysis: Mesh and Node Analysis. **Network Theorems:-** Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer, star/delta transformation and source transformation. - Simple numerical problems
Basic active Circuits elements: P & N-type semiconductors, P-N junction, forward bias and reverse bias, V-I characteristics, ideal and practical diodes, approximate model, diode data sheet, types of diodes and variants (Introductory level only), **Types of transistors (PNP and NPN)**

Applications of active elements: Clippers, Clampers, Rectifiers - HWR, FWR with and without capacitive filters. Power supply with ripple reduction and regulation, Zener diode as a voltage regulator. **Applications of Transistor:** Transistor as an amplifier, switching transistors, power transistors (low, medium and large power), key parameter from data sheet.
Analog & Digital ICs: 7805,7905, IC 741, IC 555, LM 339, LM723.

Text Books

1. John Bird. Electrical Circuit Theory and Technology, Routledge publishers, 6th edition, 2017.
2. Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad

Reference Books

1. A Sudhakar, Shyam Mohan S Palli , Circuits and Networks: Analysis and Synthesis, TMH, 5e
2. David A. Bell, Electronic Devices and Circuits, 5th Edition

20EC1202 – Computer Organization and Architecture

L-T-P-S : 2-0-0-0 Credits : 2
Pre-requisites : 20EC1101 Contact Hours : 2

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the functionality and design the CPU functional units - control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.	**1,2**	**2**
CO2	Understand, analyze and design main, cache and virtual memory organizations.	**1,2**	**2**
CO3	Understand, analyze and design different types of I/O transfer techniques.	**1,2**	**2**
CO4	Understand the design issues of RISC and CISC CPUs and the design issues of pipeline architectures.	**2,3**	**2**

Gist: (a) Number representations, ALU, Assembly, HLL, Moore, Mealey, Van-Neuman architecture, (b) CPU Design, Cache & Virtual memory, (c) I/O, DMA, storage, buses, data-transfer, (d) Pipelining, RISC, CISC parallelism.

Syllabus: Computer Architecture, Computer system and its sub modules: State Diagram various Architectures, Moore Machine, Mealey Machine, Van Neuman architecture and hardware implementation of Arithmetic and Logic Unit, Buses Types, Specifications of a computer, Concepts of Machine level programming, Assembly level programming and High-level programming. Various addressing modes and designing of an Instruction set. Concepts of subroutine and subroutine call, use of stack for handling subroutine call and return.

CPU Design: Introduction to CPU design, Instruction interpretation and execution, Micro-operation and their RTL specification. Hardwired control CPU design. Micro programmed control CPU design. Concepts of semiconductor memory, CPU-memory interaction, organization of memory modules. Cache memory and related mapping and replacement policies. Virtual memory, paging concepts, VAS to PAS and Vice-versa mapping.

Input / Output Devices: Introduction to input/output processing, working with video display unit and keyboard and routine to control them. Program controlled I/O transfer. Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Introduction to buses and connecting I/O devices to CPU and memory, TRAP and Interrupts.

Pipelining: Introduction to RISC and CISC paradigm. Design issues of a RISC processor and example of an existing RISC processor. Introduction to pipelining and design issues of pipeline architecture. Introduction to parallel computing.

Text Books

1 William Stallings, Computer Organization and Architecture: Designing for Performance, 8/e, Pearson Education India. 2010.

2 D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 4/e, Morgan Kaufmann, 2008.

Reference Books

1 V. C. Hamacher, Z. G. Vranesic and S. G. Zaky, Computer Organization, 5/e, McGraw Hill, 2002

2 Morris Mano, Computer System Architecture, 3/e, Pearson, 2008.

Web References

1 NPTEL Computer Organization and Architecture Lecture by IIT Guwahati. https://onlinecourses.nptel.ac.in /noc19_cs04/

2 MOOCS:https://www.edx.org/course/computation-structures-3-computer-mitx-6-004-3x-0

PROFESSIONAL CORE COURSES

19EC2103 – Analog Electronic Circuit Design

L-T-P-S : 3-0-2-2 Credits : 4.5
Pre-requisites : NIL Contact Hours : 7

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study of BJT's and Various application in Amplifiers	**1,3**	**2**
CO2	Understand various types of FET's, IC Types and analyze FET as an Amplifier	**1,3**	**2**
CO3	Understand the Linear & Non-linear application of Op-AMP and analyze active filters	**1,3**	**2**
CO4	Analysis of different types of oscillators, filter and regulators.	**1,3**	**4**
CO5	Design and Testing of Analog circuits for realistic applications	**5**	**4**

Gist: (a) BJTs: h-parameters, equivalent representation, biasing, feedback & power amp, (b) FETs & MOSFETS, (c) Op-Amps, Schmitt Triggers, CMRR, IC 741, Oscillators, (d) Timer IC 555, Multi-vibrators, Filters (1st & 2nd Order), Regulators ICs and PLL.

Syllabus:

Transistor Amplifiers: BJTs: Biasing, types of biasing, h-parameters, equivalent representation of a transistor using h - parameter model, self bias design, amplifier design from biasing, amplifier analysis using h-parameters (Gain, Bandwidth, input and output impedances), Design of a CE amplifier. Negative feedback amplifiers: need for negative feedback, feedback characteristics, 4 topologies (quantitative analysis only), comparison of the input and output impedances of all the four topologies. Power amplifiers: concept of power amplifiers, class A class B and class AB, class C and class D power amplifiers, Distortion analysis. (Introductory level only)

FETs and MOSFETs: FETs: Theory and fundamentals, classification of FETs, JFET, MOSFET, DMOS, EMOS, CMOS, VMOS (introductory level only), FET (BFW10) data sheet, CMOS ICs, difference between CMOS and TTL ICs, biasing, FET characteristics, Channel length modulation, FET amplifier and analysis (Gain, Bandwidth, input and output impedances). IC Design & Fabrication: Introduction to different types of ICs and Packaging's, IC Design and Fabrication.

Operational Amplifiers: Basics: Ideal OPAMP, OPAMP characteristics, ideal and practical OPAMP, CMRR, slew rate, Virtual Ground, inverting and non inverting amplifiers,
(3 hrs)

Applications of OPAMPs: Adders, subtractors, scaling amplifier (using LM324 - Quad OPAMP), Integrator, Differentiator, comparator using 710 IC, Schmitt trigger, Instrumentation amplifier. Active filters: design of LP, HP, BP, BS filters (Butterworth filter, first order and 2nd order).

Misc. Topics:

Oscillators: Function generator using LM1428, Barkhausen's criteria for sustained oscillations, Classification of oscillators, RCPS, WBO (using 741 OPAMP), Hartley and Colpitts oscillators (using transistors), crystal oscillator, 555 Timer, functional architecture of 555, Astable, monostable and bistable operation using 555. (6 hrs) Filters: Continued LC Filters, RC Filters, RLC Filters, ripple factor for Half Wave rectifier and Full wave Rectifier.

Regulators: Concept of regulation, Design of voltage regulators using LM339, IC 723, 78XX and 79XX series, SCR, Triac.

Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell
3 Linear IC Applications - Ramakanth Gaykwad

Reference Books

1 Integrated Electronics by Millman & Halkias
2 Electronic Circuits by Schilling & Belove
3 Digital Integrated Electronics by Taub and Schilling

S. No.	List of Experiments
1	Transistor as a switch, as a squarer, as an opto driver, as a logic gate
2	Design of Zener diode as a voltage regulator and Transistor regulator
3	Design of a plus minus DC Adapter
4	Design of a Audio amplifier with speaker as a load
5	Design of hybrid FET-BJT amplifier
6	Design of Scaling Amplifier using LM324/ 741
7	Design of 80db notch filter
8	Design of Hartley and Colpitt's Oscilator
9	Design of Astable multivibrator with relay driven blinking LED using 555
10	Design of Monostable Multi Vibrator

S. No.	Mini projects
1	Smart irrigation system using soil moisture sensor
2	Measurement of BMI using load cell and ultra-sonic sensor
3	Measurement of EMG
4	Measurement of blood pressure using BMP180 sensor
5	Design of valve controller using potentiometer

19EC2104 – Communication Signals & System Design

L-T-P-S : 3-1-0-0 Credits : 4
Pre-requisites : NIL Contact Hours : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Ability to represent Analog signal(s) as mathematical function(s) and Manipulate them into more desirable function(s) by using the several available mathematical operations. Understand the three types of system representation. Ability to compute the response of the system for any given input and impulse-response function.	**1,6**	**2**
CO2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	**1,3**	**2**
CO3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	**1,2,8**	**2**
CO4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain	**12/1**	**3**

Gist: (a) Basic: LTI, Convolution, correlation, Laplace T. (b) Fourier Transform, Hilbert Transform, (c) Sampling, Quantization and Reconstruction, Z-transform, (d) ARMA model, poles, zero's, DTFT.

Syllabus: Basics of Analog Signals and Systems: World view of signals, Classification of signals, Mathematical representation of classifications, Basic signals, Operations on signals, Build complex signals from basic signals, Correlation. Introduction to Systems concept, Properties of systems, LTI system, impulse response, convolution, Properties of LTI system.

Signal Transformations and Translations: Laplace Integral, LT of basic signals, Inverse Transfer function, Transfer function of LTI system, ROC. Fourier Integral, FT of basic signals, from F.S to F.T, Properties of FT, Frequency translation, Dirichlet conditions, Parseval's theorem, Frequency response. Power spectrum-Graph. Hilbert integral, applications. Weiner-Khinchin Theorem (optionally).

Analog to Discrete World: Basics of Sampling-Graphical, Nyquist-Shannon Theorem, Graphical proof for band limited signals, Band pass sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Quantization and Quantization error. Cauchy Integral theorem (optionally), Z-Transform and its ROC, Inverse Z-Transform, Properties.
Systems Design and Analysis: ARMA model, Poles & Zeros, Stability. DTFT, Analysis and synthesis, Differences between FT, DTFT, DFT -Graphically. DTFT of standard sequences. DFT of standard sequences-Graph, magnitude and phase spectrum, Properties.

Text Books

1 Signals, Systems, and Transforms, Phillips, Parr and Riskin, Fourth Edition, Pearson Education, 2008.
2 Statistical Digital Signal Processing and Modelling, Monson H. Hayes, 2009.
3 Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.

Reference Books

1 Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
2 Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition
3 Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008.

20EC2106 – Embedded Controllers & Embedded System Design

L-T-P-S : 3-0-2-2 Credits : 4.5
Pre-requisites : NIL Contact Hours : 7

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the architecture and programming concepts of 8086 Microprocessor	**1,2**	**2**
CO2	Apply the Programming concepts of 8051 Microcontroller	**5**	**3**
CO3	Analyse the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers	**3**	**4,2**
CO4	Understand the basic concepts of CORTEX STM-32 microcontroller and RTOS	**2**	**2**
CO5	Analyze the applications of programming with 8051 and 8086 on hardware / software. Analyze the applications of programming with Arduino	**5**	**4**

Gist: (a) Basics: 8086 Architecture & Instruction set, (b) µC Fundamentals: 8051, (c) Peripherals, I/O, ARM7, (d) CORTEX (STM32) and RTOS, SoC

Syllabus:

Basics of Embedded System: Basics, Introduction and History of Processors, 8086 Architecture, Instruction set, 8086 programming and examples.

Microcontroller Fundamentals: 8051 Architecture, Addressing modes, Instruction set, Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Interrupts.

Serial Data Communication and RS-232C Standard with 8051 Programming, Peripherals and Input Output with 8051 Microcontroller (PIO, Timers and Interfacing).

Modern Microcontrollers: Introduction and Architecture of PIC Microcontroller, Introduction of ARM7 (LPC2148), Basic Architecture of ARM7, Pin Description, Advanced Microcontroller Bus Architecture (AMBA).

Advanced Topics: Introduction to CORTEX (STM 32), Architecture and Introduction to RTOS (Real Time operating systems). Basic concepts and applications of RTOS.

Text Books

1 Mazidi & McKinley “The 8051 Micro controller and Embedded systems: using assembles and C, 2nd edition, 2007.

2 Frank Vahid, “Embedded System Design”, Wiley; Student edition (2006).

3 A K Ray and K M Bhurchandi “Advanced Microprocessors and Periperals “ The McGraw Companies,2nd Edition,2006

Reference Books

1 Make: Arduino Bots and Gadgets: Six Embedded Projects with Open Source Hardware and Software by Tero Karvinen, Kimmo Karvinen

2 Practical Microcontroller Engineering with ARM Technology by Ying Bai

Web References

1 https://www.youtube.com/watch?v=DmwOSdwzZ3E
2 https://www.youtube.com/watch?v=GPz_mR7Flas
3 https://www.youtube.com/watch?v=fI20Bsx3EPM
4 https://www.youtube.com/watch?v=S2_KtA_6y80

S. No. List of Experiments

1 Implement Arithmetic Operations and Find the number of Positive and Negative numbers in a given array using 8086 Programming, and transfer the program to EEPROM.

2 (a)Write ALP to Sort the Array of Numbers in ascending and descending order using 8086 Programming.

(b)Optional: Different methods of sorting numbers can also be attempted for programming.

3 Design a System to display the continuous Count on seven segments LED Display using Arduino Microcontroller Board.

4 (a) Design Doorbell Music Synthesis with buzzer using Arduino Microcontroller Board.

(b) Optional: Doorbell Tone/Music may also be synthesized.

5 Design Temperature controlled fan with LM35 and Arduino Microcontroller Board.

6 Design a Traffic Light controller System using Microcontroller 8051 Programming.

7 Design a System to count the number of students entering to a class. And then:

(a) Display the same on 16X2 LCD,

(b) Also send the Data to PC using RS-232 interfaced with Microcontroller 8051.

8 (a) Develop an Assemble Language/ C Program to interface a DC Motor and L293D driver with Microcontroller 8051.

(b) Optional: Design the prototype of Elevator with DC Motor and L293D using 8051 programming.

9 Interface a Servo Motor with ARM7/Raspberry Pi Microcontroller Board.

10 Design a Garbage monitoring system using Ultrasonic Sensor with ARM7/Raspberry Pi Microcontroller Board.

11 Design an Automatic LPG Gas Detection System using ARM7/Raspberry Pi Microcontroller Board.

S. No. Mini projects (Default Options)

1 Design Bluetooth controlled industrial automation with android applications using a Microcontroller Board.

2 Design RFID interfacing for any real time application using a Microcontroller Board.

3 Design a communicating system with GSM Module using a Microcontroller Board.

4 Design Weather Monitoring System for IOT application using a Microcontroller Board.

19EC2105 – Analog and Digital Communication

L-T-P-S : 3-0-3-0 Credits : 4.5

Pre-requisites : NIL Contact Hours : 6

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyse the linear and non linear modulation concepts	**1**	**3**
CO2	Explore the basic digital communication systems and principles	**1, 3**	**2**
CO3	Learning various line coding procedures and signalling schemes to facilitate data communications.	**1, 3**	**2**
CO4	Understand the concepts of multiple access and various types of networks.	**1, 3**	**2**
CO5	Analysis and design of Modulation and Demodulation features of various Analog & Digital Communication Systems.	**5**	**4**

Gist: (a) Modulation: AM, FM, PM – Types, Index, Noise (b) Digital Communications: sampling, aliasing, PCM, SNR, BW, DPCM, DM, ADM,, (c) Switching, signaling, Appn: ASK, FSK, PSK, QPSK, MSK, SS7, PSTN, DSL/ADSL, T1/E1, SDH, (d) Modern Communications: FDMA, TDMA, CDMA, LAN, WAN.

Syllabus:

Fundamentals of Analog and Digital Communications

Introduction Modulation types: AM, FM, Pulse Mod, SNR, Bandwidth, Beam width, Power Spectrum.

(a) AM Concept : DSB-SC, SSB, Coherent detection, Modulation Index.

(b) FM Concept: FM Clicks, Modulation Index, FM Clicks &Threshold and Phase Modulation

(c) Pulse Mod. Concept: PAM, PWM, PPM Modulation and Demodulation using IC

Formulae and Numericals; Transceiver, Noise and types of noise.

Digital Communication Basics: Sampling theorem and aliasing, PCM: Quantization noise, SQNR, Formulae and Numericals, SNR vs Bandwidth; DPCM, DM, ADM coders, Formulae and numericals, Vocoders: LPC, CELP, RPE-LTP, Switching.

Signaling and Digital Communication Applications

RZ, NRZ, Bipolar RZ AMI, Manchester, HDB3 and B8ZS and circuit implementations, Bits and Bauds, ASK, PSK, FSK, QPSK, QAM, MSK, bandwidth consideration, formulae and Numericals.

Telecomm Systems: circuit switching, T1/E1, SS7 signalling, PDH and SDH, DSL/ADSL,PSTN Switching.

Modern Communication Methods

Multiplexing and Multi access, FDMA, TDMA, CDMA, CSMA; OFDMA, Rake receiver, Spread spectrum Techniques.

Data Commm Systems: Packet Switching, PAN, LAN, WAN, MAN, Internetworking, VoIP.

Text Books

1. Simon Haykin and Michael Moher, "An Introduction to Analog and Digital Communications", 2nd Ed., Wiley, (2007).
2. Wayne Tomasi, Advanced Electronic Communication Systems", 6th Ed.,Pearson Education.
3. B. Forouzan," Data Communications and Networking", 4th Ed., Mc graw Hill.
4 W. Stallings," Data and Computer Communications",8thEd.,Pearson Education.
5 T. Rappaport," Wireless Communications Principles and Practice", 2nd Ed., Pearson Education (2009).

Reference Books

1 H Taub & Schilling, Gautam Sahe," Principles of Communication Systems", TMH, 3rd Edition, (2007).
2 R.P. Singh & S.D. Sapre," Communication Systems: Analog and Digital", Mc Graw Hill, 3 rd edition.

Web References

1 https://onlinecourses-archive.nptel.ac.in/
2 https://www.coursera.org/

S. No. List of Experiments

1 Generate Amplitude modulated Signal and perform demodulation.
2 Generate Sine, Square, triangular wave and Frequency modulated wave using XR 2206 IC.
3 Generate PWM and PPM Signal using 555 timer.
4 Demonstrate analog to digital conversion and digital to analog conversion.
5 Design circuit to generate Amplitude Shift Keying signal using LM 398 and PSK signal using BJT.
6 (a)Generate FSK signal using 4053 IC .
(b) (Optional) Generate QPSK signal using Jhonson Counter.
7 (a)Demonstrate conversion of NRZ signal to Manchester line coding signal .
(b)(Optional)Demonstrate Conversion of NRZ to RZ line coding signal.
8 (a)Design a circuit to generate AMI line coding signal.
(b)(Optional)Design DTMF Encoder and Decoder circuit.
9 Demonstrate Time division multiplexing and Demultiplexing.
10 (a)Demonstrate Frequency division multiplexing and Demultiplexing.
(b) (Optional)Design Delta mod and Demod circuits.

Note: Optional experiments would fetch extra bonus marks, if done along with main experiment.

19EC2207-**Electromagnetic fields & Applications**

L-T-P-S : 3-1-0-0 Credits : 4
Pre-requisites : NIL Contact Hours : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of EM fields and magnetic fields	**1,2**	**2**
CO2	Study of wave propagation in wave guides, coaxial cables and other materials.	**1,2**	**2**
CO3	Analysis and study of application s of EM waves	**1,2**	**3**
CO4	Analysis and study of advanced topics in EM wave applications	**1,2**	**3**

Syllabus:

Basics of EM Theory

a) Introduction to Electromagnetic fields, significance, and possible range of applications.
b) Electromagnetic spectrum: various frequency bands
c) Electric fields: Charge distributions, Coulomb's Law, Electric field intensity, electric flux density, Gauss's Law, current densities, equation of continuity, Boundary conditions.
d) Magnetic fields: Biot-Savart's Law, Ampere's circuital law, Stoke's theorem, force on a current element in magnetic field**,** Boundary conditions.

EM waves and propagation
Faraday's laws, Maxwell's equations, EM fields, Wave propagation theory, Wave propagation in free-space, TE,TM, TEM waves, Energy, Guided-waves, Transmission lines,Wave guides, Co-axial cables, Electromagnetic Materials, Metamaterials.
Applications of EM waves Wireless, Wifi, Signaling in railways, Sensing techniques for studying biological cells, Microwave Oven, Microwave Imaging Methods, Telemetry, Medical Applications, Microwave Spectroscopy, Ion-Thruster for Space Applications, Agricultural Applications, Food Processing Applications.
Advanced topics on EM waves
Radars, Defense Applications&Stealth, Weather Applications& millimeter Radars, EMI/EMC, Nuclear magnetic resonance imaging(nMRI),Reflectivity &Shielding methods.

TEXT BOOKS:

1. W H.Hayt& J A Buck : "Engineering Electromagnetics" TATA McGraw-Hill, 8th Edition 2014
2. Mathew O Sadiku, "Elements of Electromagnetics ", Oxford University Press, 2015.
3. EC.Jordan, "EM waves and Radiating Systems", International Edition, 2011.

REFERENCE BOOKS:

1. Constantine A. Balanis," Advanced Engineering Electromagnetics" John Wiley.
2. John D Ryder , "Netwotk Lines and fields", 2nd Edition, PHI.
3. Handbook of Electromagnetic Compatibility, ISBN: 978-0-12-550710-3
4. Skolnik, "Introduction to radar systems".

Web References:

1. https://www.hindawi.com/journals/ijap/si/743765/cfp/
2. https://www.mwrf.com/systems/microwave-energy-powers-many-industrial-application
3. https://prezi.com/u_y0gyyahhz8/waves-medical-and-industrial-applications/
4. https://study.com/academy/lesson/technological-applications-of-electromagnetic-waves.html
5. http://www.scienceclarified.com/everyday/Real-Life-Physics-Vol-3-Biology-Vol-1/Electromagnetic-Spectrum-Real-life-applications.html
6. http://www.justscience.in/articles/applications-of-electromagnetic-waves/2017/05/25

19EC2208 – Digital Signal Processing

L-T-P-S : 3-0-2-0 Credits : 4
Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Analysis of FFT & Wavelets	**1,2**	**2**
CO2	Explore and Design the Digital filters: Digital FIR	**2**	**3**
CO3	Analysis and Design the Digital filters: Digital IIR	**2**	**3**
CO4	Understand and apply multi-rate signal processing, interpolation and decimation concepts	**3**	**2**
CO5	Design and Analysis of LTI Systems and Filters	**3**	**4**

Syllabus

FREQUENCY TRANSFORMATIONS

Introduction to DTFT and DFT (Realization using MATLAB) – Properties of DFT – Circular Convolution– FFT Algorithms: Decimation – in – time Algorithms, Decimation – in – frequency Algorithms, concept of Z Transform for system function (Realization using MATLAB Realization using MATLAB), Review of D.T Sequences & systems

IIR FILTER DESIGN

Block Diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems: lattice and lattice-ladder structures, Transposed forms. Concepts of Butterworth analog Low pass filter design – Discrete time IIR filter from analog filter Realization using MATLAB Realization using MATLAB) – IIR filter design by Impulse Invarianc Realization using MATLAB Realization using MATLAB) e, Bilinear transformation, Approximation of derivatives – (LPF, HPF) filter design using frequency translation.

FIR FILTER DESIGN

Direct and cascade form Structures for FIR Systems, Linear phase FIR structure - FIR filter design Realization using MATLAB Realization using MATLAB): using Fourier Series method, using windowing techniques (Rectangular Window, Hamming Window, Hanning Window).

ADVANCED SIGNAL PROCESSING CONCEPTS:

Decimation, Interpolation, Sampling rate conversion by rational factor Realization using MATLAB Realization using MATLAB), Design of perfectly reconstruction Filter banks-Design of delay line - Filter banks and Wavelets-Their applications for analysis of non stationary signals, speech signal compression, de-noising. Realization using MATLAB Realization using MATLAB)

Text Books

1 John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education, Prentice Hall, 2007.
2 Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Third Edition, Tata Mc Graw Hill, 2007.
Ali Ankasu, Simtha nd Kaiser "Subband and Wavelet transform: Designa and applications" Kluwer house, 1998.
3 M.Vettorli, Kovacevic, "Suband coding and wavelets," Prentice hall, 2007.

Reference Books

1. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, 2004.
2. G.J.Miao,l "Signal Processing for Digital Communications " Artech House.
3. C.S.Burrus, R.A.Gopinath, H.Guo, "Introduction to Wavelets and Wavelet Transforms," Prentice hall,2003.
4. Vinay K. Ingle, John G. Proakis," Digital Signal Processing Using MATLAB AND wavelets," PWS publishing, 2007.

Web links

1 https://www.youtube.com/watch?v=qPpNYGAQf20&list=PL9567DFCA3A66F299&index=11
2 https://www.youtube.com/watch?v=gkC7cXa8ewk&list=PL9567DFCA3A66F299&index=12
3 https://www.youtube.com/watch?v=vpPbaw9k8PY
4 https://www.youtube.com/watch?v=S6ZgQBwL-AU&list=PL9567DFCA3A66F299&index=6
5 https://www.youtube.com/watch?v=of_juuT8BMs
6 https://www.youtube.com/watch?v=kp2zPGpKd74

20EC2209A-Statistics, AI, ANN

L-T-P-S : 3-0-0-2 Credits : 3.5
Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the conditional probability and discrete distributions to suitable real- world situations.	**1,2**	**3**
CO2	Apply queuing models for single and multi-server s with finite and infinite queue capacity to suitable real world problems.	**1,2**	**3**
CO3	Study of introduction and search methods	**2,3**	**2**
CO4	Study the basics of ANN, FFN and FBNN	**1,3**	**2**

Syllabus

Random Processes and Random Variables
Probability - Coin experiment, Ball experiment, Card experiment, Dice Experiment, Sequence of Coin tossing, Combination, Permutation, Probability Density function, expectations, mean, variance, Random Processes and random variables.
Stochastic Processes
Coin tossing, 2 Coin tossing, 3 Coin tossing, Biased coin tossing, Baye's theorem. Hidden Markov Model, Trellis Algorithm, Viterbi Algorithm. Introduction to Artificial Neural Networks. Cumulative Frequency -less than type-Ogive, Cumulative Frequency- more than type -Ogive.
Introduction to Artificial Intelligence
Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI, Agents. **State Space Search**: Depth First Search, Breadth First Search, DFID
Heuristic Search: Best First Search, Hill Climbing, Python Programming implementation with Artificial Intelligence.
Basics of ANN, FFN, FBNN:
Overview of Artificial Neural Networks, Different Learning Methods and Architectures, Activation functions and its classification, Perceptron, Multi-Layer Perceptron, Hinton's Model, Feedforward Neural networks, Feed-Back Neural-networks**.** Introduction to CNN, RNN and DNN.

Text Books

[1]. Communication Systems by Simon Haykin
[2]. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.

Reference Books

[3]. R.O.Duda, P .E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.
[4]. Artificial Neural Networks by Prof. B. Yegnanarayana.
[5]. Simon Haykin, Neural networks and learning machines, Pearson Education, 2016
[6]. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003

Web References

1 https://nptel.ac.in/courses/106106126/
2 https://nptel.ac.in/courses/106105077/
3 https://nptel.ac.in/courses/111102014/

20EC2209-AI & ANN Tools and Applications

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

CO. No	Course Outcome	Mapped PO	BTL
CO1	Understand the basics of Probability, statistics and its Applications.	1,2	1,2
CO2	To understand the applications and tools of AI	1,2	2,3
CO3	To understand the concepts of AI searching techniques and ANN models	1,2	2,3
CO4	To Implement AI and ANN Models for real time problems	1,2	1,2

Syllabus:

Random Processes and Random Variables

-Probability: Coin experiment, Ball experiment, Card experiment, Dice Experiment;
-Combination, Permutation, Random Processes and random variables;
-Introduction to Sequence of Coin tossing: Joint probability examples and Hidden Markov Model

Applications of AI &Tools

-Introduction to MATLAB, Python, R tools for Statistical analysis;
-AI Virtual Agents, AI Chatbots, AI for Personalized Shopping Experience;
-Artificial Intelligence in Agriculture;
- Introduction to 3rd party AI tools

Basics of AI &ANN

-Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI.
-State Space Search: Depth First Search, Breadth First Search,DFID
-Overview of Artificial Neural Networks, Different Learning Methods and Architectures.
-Supervised and Un-supervised learning concepts: Activation functions and its classification, Perceptron;
Neural Network Classifiers: Multi-Layer Feedforward Neural networks, Multi-Layer Feedback Neural Networks.

AI, ANN Models, Implementation and Case Studies

-Implementation of AI: Programming implementation with Artificial Intelligence;
-Implementation of Search techniques for pattern recognition;Hill Climbing, Travelling salesman problem;
-Implementation of 2-class pattern recognition;
-Image recognition using Feedback Neural networks;
-Introduction to CNN

Text Books

[1]. Probability, Random Variables and Random Signal Principles By Peyton Peebles., Tata Mc Graw-hill
[2]. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, Elsevier Science & Technology, 2011.

References

[3]. R.O.Duda, P .E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.
[4]. Artificial Neural Networks by Prof. B. Yegnanarayana.PHI
[5]. Artificial Neural Networks by Simon Haykins
[6]. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003

Web References

1 https://www.coursera.org/learn/probability-statistics
2 https://www.coursera.org/learn/probability-intro
3 https://www.coursera.org/specializations/ai-foundations-for-everyone
4 https://www.coursera.org/learn/neural-networks-deep-learning

19EC2210-Data Networks & Protocols

L-T-P-S	: 3-0-2-0	Credits : 4
Pre-requisites	: NIL	Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	**Course Outcome**	**PO/PSO**	**BTL**
CO1	Understand the fundamentals of networking and protocols	**1**	**2**
CO2	Understand the networking technologies	**1**	**2**
CO3	Understand the Access networks	**2**	**2**
CO4	Understand the concepts of modern networking	**2**	**2**
CO5	Analysis and study of concepts of networking.	**5**	**3**

Syllabus:

Introduction to Computer networks and Data Link Layer:

Introduction to Computer networks Use of Computer Networks, Network Hardware, Network software, Reference models: OSI and TCP/IP, Example Networks, Physical Layer: The theoretical basis for Data Communication, Guided and Unguided Transmission Media, Switching, Modems, ADSL, Trunks AND Multiplexing.

Data Link Layer: DLL design issues. Error Detection and Correction, Elementary data link protocols, sliding window protocols. Medium Access Control Sub layer: Channel allocation problem, multiple access protocols, Ethernet.

Network layer and Internetworking

Internetworking Devices: Preamble to Network Layer**,** Distinguishing of Networking Devices and **Internetworking Devices**, Analysis of Router Processing: Access, core and distribution. VLANS, Ethernet

Internetworking Technologies: Wired Router, Wireless Router, Gateway, CSU/DSU; Addressing: IP addressing (IPV4 & IPV6), subnetting; Types of Routing: static, default and dynamic.

Networking Protocols: RIP, OSPF, BGP; Access Control list for IPV4, IPV6, Other Protocols: NAT, ARP, Port Address Translation (PAT), IP Tunneling; DHCP

Transport layer, Session Layer, Presentation Layer and Application Layer:

Transport Layer: Process to Process Delivery; UDP; TCP; FCP Fiber Channel Protocol; Stream Control Transmission Protocol (SCTP); Congestion Control: Open Loop, Closed Loop Choke Packets; Quality of Service: Techniques to Improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Session Layer: ISNS Internet Storage Name Service.

Presentation Layer: SSL , preface of Socket , Secure Socket Layer

Application Layer: Telnet, TFTP, POP3, DNS, SMTP, SNMP, FTP, NTP, SSDP.

Advanced Topics:

Cryptography: Public and Private Key based) Digital Signature , Firewalls

Advancements in Application layer: ISDN services & ATM, DSL technology, wired and wireless Modem: Architecture & Operation in brief.

Wireless LANs: IEEE 802.11; Multi-Band Routers (Tri Band Wireless Routers);

Network Security: Essential Steps for Configuring a New Server and firewalls, Different types of network layer attacks and IP security.

Text Books

1 Data Communications and Networking (3rd Ed.) "–B. A. Ferouzan – TMH

2 Computer Networks (4th Ed.)", A. S. Tanenbaum – – Pearson Education/PHI

Reference Text books

1 Data and Computer Communications (5th Ed.)" – W. Stallings – PHI/ Pearson Education

2 Network for Computer Scientists & Engineers, Zheng & Akhtar, OUP

3 Data & Computer Communication, Black, PHI
4 Data Communication & Network, Miller, Vikas
5 Digital & Data Communication, Miller, Jaico
6 Understanding Data Communication & Network, Shay Vikas

Web References

1 Kurose and Rose – "Computer Networking -A top down approach featuring the internet"– Pearson Education
2 "Communication Networks" – Leon, Garica, Widjaja TMH
3 "Internetworking with TCP/IP, Comer – vol. 1, 2, 3(4th Ed.)" – Pearson Education/PHI

FLEXI CORE COURSES

19EC3015 – VLSI Design

L-T-P-S : 3-0-2-0 Credits : 4

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the MOS device fabrication process	**2,3**	**2**
CO2	Analysis of MOS operation principles, characteristics and scaling process	**2,3**	**3**
CO3	Constructing the Transistor Level Logic circuits and understand the MOS layout design rules	**2,3**	**3**
CO4	Study of MOS circuit performance and testing principles	**3,4**	**3**
CO5	Create the MOS circuit modules through project-oriented approach using e-CAD tools	**5**	**4**

Syllabus:

Basics of VLSI Design & IC Technology: MOS transistor analysis, Transistors Fabrication steps – PMOS, NMOS, CMOS & Bi-CMOS. Current-voltage characteristics of MOSFETS, MOS drain current equation and regions of operation, threshold voltage and body effect, second order effects.

NMOS and CMOS Inverters: MOS Inverters: Resistive load, depletion load, enhancement load, CMOS inverter, Static and Dynamic characteristics, Inverter Delay, Dynamic & Static Power Dissipation. W/L ratio for NMOS and CMOS inverters, noise margin, NMOS and CMOS Voltage transfer Characteristics, Latch up in CMOS Circuits. Scaling of MOS Circuits.

VLSI Circuits and Design Methods: NMOS, CMOS and Bi-CMOS Inverter design and analysis. NMOS, CMOS, Pass Transistor and Transmission Gate based logics, Stick Diagrams and layouts for digital Logics, Design rules: lambda-based design rules.

Design for Testability: Sheet Resistance RS, Area Capacitance and Delay calculations. CMOS Fault models, Testing of Combinational logics, testing of sequential logics, Scan design techniques, Built-In-Self-Test (BIST).

Text Books

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Ed., 2011

2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Ed., 2011

3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Tata Mc-Graw-Hill, 3rd Ed., 2003

Reference Books

1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Ed., 2012

2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Ed., 2009

19EC3016 – Wireless Communications

L-T-P-S : 3-0-2-0 Credits : 4

Pre-requisites :NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts of wireless communications & various Technologies	**1,2**	**2**
CO2	Understand the basic concepts of mobile radio propagation	**2,3**	**2**
CO3	Understand the basic concepts of equalization and diversity techniques	**2,3**	**2**
CO4	Understand and applications of concepts of multiple access techniques	**3,4**	**3**
CO5	Analysis and design of electronic circuits for modern communication standards	**3,4**	**4**

Syllabus

Introduction to Wireless Communications: Examples of Wireless Communication Systems, Cellular telephone Systems, 2G & 3G wireless networks, Cellular concept, frequency reuse, Channel Assignment strategies, Hand off strategies, Interference and system capacity, improving coverage and capacity in cellular systems.

Mobile Radio Propagation: Large Scale Fading, Free space propagation model, Three basic propagation mechanisms: Reflection, diffraction, scattering, Small Scale Fading, Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, fading effects due to multipath delay Spread and Doppler spread, Rayleigh and Ricean distribution models. Statistical models for multipath fading channels.

Equalization and Diversity Techniques: Equalization, Fundamentals of Equalizers, Linear equalizers, nonlinear equalizers, Decision feedback equalizers, MLSE, Algorithms for adaptive equalization, Space diversity, MRC, EGC, selection diversity, Polarization diversity, Frequency diversity, Time diversity, Rake receiver. Multiple Access Techniques – TDMA, FDMA, CDMA.

Wireless Systems and Standards: GSM Services Features, Architecture, Channel types. Frame Structure, CDMA (IS95), PACS, Personal Communication Satellite Systems (PCSS), IEEE 802.11A, UMTS and 4G Technologies – OFDM for wireless communications.

Text Books

1 "Wireless Communications Principles and Practice", Theodore S. Rappaport, 2nd Edition, Pearson Education, 2003.

2 "MIMO Wireless Communications", Ezio Biglieri, Andrea Goldsmith, Arogyaswami Paulraj, Cambridge University press, 2007.

Reference Text books

3 "New directions in wireless communication research", V. Tarokh, Springer,2009

4 "Orthogonal Frequency Division Multiplexing for Wireless Communications", Ye (Geoffrey) Li, Gordon Stuber Springer, 2006.

Web References

1 W. C. Y. Lee, "Mobile Cellular Communications, 2nd Edition", Mc Graw Hill, 1995.

2 Simon R. Saunders, Alejandro Aragon Zavala, "Antennas and Propagation for Wireless Communication Systems", 2nd Edition, John Wiley & Son, 2007.

3 Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

19EC3017 – RF System Design

L-T-P-S : 3-0-2-0 Credits : 4

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Importance of RF Circuit Design, RF behaviour of passive components, Compare Types of Transmission Lines and represent Equivalent Circuits	**1,2**	**2**
CO2	Understand and analyse he RF diode, BJT and FET characteristics, and modelling amplifier input and output impedance matching with Graphical AID/Tool for RF Design;	**2,3**	**2**
CO3	Analyze Stability Considerations and stabilization methods to design RF Amplifiers Using Small Signal Analysis	**2,3**	**3**
CO4	Analyze high frequency oscillator configuration and mixer designs.	**3,4**	**3**
CO5	Analysis and design of RF electronic circuits	**3,4**	**4**

Syllabus

Introduction to RF System Design*:* Importance of RF and Microwave Circuit Design-Dimensions and Units- Frequency Spectrum - RF Behavior of Passive Components: High

Frequency Resistors, Capacitors, Inductors, The Smith Chart: Introduction, Applications of Smith chart: Impedance measurement for single and double stub.

Design considerations of RF Filters: RF Filter Design: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modeling, Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations.

Design Considerations of RF Amplifiers and Oscillators: Characteristics of amplifier-amplifier power relations-stability consideration-constant gain-broadband, high power, and multistage amplifiers, Small signal analysis of amplifiers. Basic oscillator model-high frequency oscillator configuration.

Other Design Considerations and Real-Time Applications:

Design considerations of RF Receiver, Mixer in communication receiver, Optimization techniques. Applications: Wireless Transceiver design.

Text Books

1 Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition

2 Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.

Reference Books

1 Joseph . J. Carr, "Secrets of RF Circuit Design", McGraw Hill Publishers, Third Edition.

2 Ulrich L. Rohde and David P. New Kirk, "RF / Microwave Circuit Design", John Wiley & Sons.

3. Roland E. Best, "Phase - Locked Loops: Design, simulation and applications", McGraw Hill Publishers 5th edition.

4. Devendra K.Misra , "Radio Frequency and Microwave Communication Circuits – Analysis and Design", John Wiley & Sons, Inc.

19EC3018 – Biomedical Electronics & IOT for Healthcare

L-T-P-S : 3-0-2-0 Credits : 4

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of measuring instruments, transducers, and bio-electric amplifiers/recorders	**1,2**	**2**
CO2	Study of various bio-signals	**2,3**	**2**
CO3	Understand and analysis of various modern bio-medical instruments	**2,3**	**2**
CO4	Study of modern IoT application for health care	**3,4**	**2**
CO5	Design and development of IoT applications for health care	**3,4**	**4**

Syllabus

Bio potential recordings and measurements: The origin of Bio-potentials, bio-potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, lead systems and recording methods, typical waveforms and signal characteristics, Non electric parameter measurements, pH, PO2, PCO2, colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood Cell Counters.
Medical Instrumentations: Cardiac pacemakers, DC Defibrillator, Dialyser, Heart lung machine, Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy Telemetry principles, frequency selection, biotelemetry, radio-pill, electrical safety, Recent Trends in Medical Instrumentations, Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine

IOT for Healthcare: Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device, Industrial/Healthcare sensors – Description & Characteristics–First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors' Swarm – Description & Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap

Application of IOT In Healthcare: smart-wearables, smart-clothing, elderly fall-detection, infant care system, Monitor an aging family member, Scalable, continuous, heart rate monitoring

Text Books

1 Hemalatha Rengasmy & Jeganathan, “Biomedical Techniques and IoT Applications in Health Care” LAP LAMBERT Academic Publishing, 2019.

Web References

1 https://www.udemy.com/course/iot-based-emergency-health-care-system/
2 https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106105195/lec51.pdf
3 https://www.youtube.com/watch?v=O0CHWFc-gO8
4 https://www.youtube.com/watch?v=thCFMeB8pHM&list=PLKcjQ_UFkrd7zbPHRkDpB7i113wDG_Rb3
5 https://www.youtube.com/watch?v=dSRWgyXzZeA
6 https://www.youtube.com/watch?v=8qqWwLc4e44

19EC3019 – Electronics Instruments & Automation

L-T-P-S : 3-0-2-0 Credits : 4
Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of measurement and calibration	**1,2**	**2**
CO2	Understand and study of various electronic instruments	**2,3**	**2**
CO3	Understand the basics of control systems and automation	**2,3**	**2**
CO4	Study and analysis of industrial automation	**3,4**	**2**

CO5	Design and development electronic measurement circuits suitable of automation	**3,4**	**3**

Fundamentals of Electronics instrumentation and *Measurements:* Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Precision, Accuracy, Error-Types, Sensitivity, Resolution, Standards, Calibration - Primary and secondary standards. 4P
Sensors and measurements: Active and passive transducers, Resistance, inductance and capacitor measurements. Strain Gauge: LVDT, RTD, Thermistor, thermo couple etc. 6P

Syllabus

Electronic Measuring *Instruments:* Analog and digital measuring Instruments: Ohm meter, AC/DC Ammeter and Voltmeters. CRT: Measurements of Voltage, current, phase and frequency, Signal generators, sweep generators. 4P

ADC, Signal conditioning, Instrumentation Amplifiers, Digital instruments: Digital Multimeter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer, Digital pH meter, Digital capacitance meter. Interfacing buses. 6P

Control Systems & Automation Basics: Feedback, Steady-state, Sensors, Automation, Robots.

Open loop and closed loop feedback systems, Proportional, derivative and integral control action. PID controller tuning rules. Compensator design using Bode diagram in frequency response approach. Lag, Lead, Lag-lead compensator. 5P

Sensors, Introduction to machine vision, sensing and digitizing, Introduction to robots: definition of robot - basic concepts - robot configurations - types of robot drives - basic robot motions - point to point control - continuous path control. 5P

Automation: CNC, Home/Ind. Automation, Appns of Sig-Proc, Machine Vision, AI, Robotics]

Automation overview, Requirement of automation systems, Automation components: Actuators, process control valves. Introduction of DC and AC servo drives for motion control. 3P

Computer aided measurement and control systems: Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, Industrial communication systems, Data transfer techniques, Computer based data acquisition system, Internet of things (IoT) for plant automation. Concept of AI. 4P

Industrial automation using robots: Basic construction and configuration of robot, Pick and place robot, Welding robot. 3P

Text Books

1 A.K.Sawhney,―Electrical & Electronics Measurement and Instrumentation‖,10th edition, DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.

2 Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies.

Reference Books

1 Process Control Instrumentation Technology By. C.D. Johnson, PHI

2 Industrial control handbook, Parr, Newnem

19EC3020 – System Engineering, Operation Research & Designing

L-T-P-S : 3-0-2-0 Credits: 4

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction to the concepts and techniques of system design	**1,2**	**2**
CO2	Understand the basic of operation research	**2,3**	**2**
CO3	Understand and application of design objectives, industry & market forces and product design strategies	**2,3**	**3**
CO4	Understand and analyze the product design goals, methodologies.	**3,4**	**3**

Syllabus:

Introduction to system Design[: Systems Engineering – Basic Definitions - System Life cycles -Phases-Steps, Formulation of Issues: Problem Identification – Scoping – Bounding, Problem definition – Identification of needs, alterable, constraints; Value System Design: Objectives and objective measures; Functional decomposition and analysis Tools: Objectives hierarchies – trees, cross interaction matrix; Functional analysis approaches – Node tree, Context diagram, system decomposition;

Decision Making :

Types of decisions – descriptive, prescriptive, normative; Decision assessment efforts types – under certainty, probabilistic uncertainty

Basics of Operation Research[4-6]: Introduction to Operation Research; operations Research Models; Characteristics of operations research; Structure of the Mathematical Model, Limitations of Operations Research ; Solving the OR Model; Queuing and Simulation Models, objective of operations research; Introduction to Foundation mathematics and statistics Linear Programming (LP), LP and allocation of resources, LP definition, Linearity requirement; Objective Functions; Costs; Constraints;

Finite Queuing Models[4-6]: Introduction, Finite Queuing Models; Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT; Game Theory: Introduction, Competitive Situations, Characteristics of Competitive Games, Maximin – Minimax Principle, Dominance; Models and Modeling in Operations Research, Advantages and Applications of Optimization Models.

Design objectives[4-6]: introduction to Design Objectives(DO); types of Design Objectives, operation of product & Services, user interfaces, visual& sensory,, technology, environment, design considerations, lightness, design constraints, design to cost, Design-to-value vs Design to Cost; design to value;

Strategic Research Agenda (SRA)[4-6]in Industry, Market forces SRA, Product design strategies: survey, envision, develop, deliver; PDS tactics Discover, Design, Build, And Launch, ATP (Available to Promise) ATP

User Interface (UI), User Experience (UE) & Product Design[4-6]: Definition, principles and practice of User Interface (UI) / User Experience (UX); Elements of User Experience Design. Designing parameters of User Experience (UX), lifecycle of design—the process, purpose, and tools, architectural operations on (UX), human centered design, product design, UI/UX design, Usability Test process of UI & UX,

Product Designer (PD)[4-6]: Evolution of UI/UX Designers into Product Designers, product design and development of UI and UX. Design Thinking of product interfaces and user interface, integration of small, medium, large scale UI & UX project development training module. Web design-based UI

Text Books

1 Andrew P Sage and James E Armstrong, Systems Engineering, Wiley Inter science publications (2004)

2 Alexander Kossiakoff, William N. Sweet, Systems Engineering : Theory & Practice, John Wiley & Sons, 2002

3 James N. Martin, Systems Engineering Guidebook: A Process for Developing Systems and Products, CRC Press, 1997

4 UI UX Design Hardcover – Illustrated, 25 Dec 2016 by Xia Jiajia

Web References

1 Handbooks in Operations Research and Management Science

2 Web UI Design Patterns 2016 Volume 2: Layouts, Content, Data, Scrolling, Multimedia

19EC3021 – Electrical Technologies & Solar Power Systems

L-T-P-S : 3-0-2-0 Credits: 4
Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of electrical technology	**1,2**	**2**
CO2	Study and understand of power generation, transmission and distribution.	**2,3**	**2**
CO3	Study of electrical grids, smart grids, IoT applications in smart grids and remote management	**2,3**	**2**
CO4	Analysis and study of solar photo voltaic cells, AI & ML in solar cells array and networks	**3,4**	**2**
CO5	Design and analysis of photo voltaic cells for power generation and implementation of AI & ML for the analysis of solar cell arrays.	**3,4**	**3**

Syllabus:

Basics of Electrical Technologies: Elementary concepts of electric circuits, Kirchhoff's laws, constant voltage and current sources, Electromagnetic induction, DC Machine, DC Generators, DC Motors, Three phase systems, star and delta connection. Transformers and bus bars.
Power Generation and Distribution: Elements of the power grid and measurement technologies: generation, transmission, distribution, and end-user; Basic concepts of power, load models, load flow analysis and losses. Distribution system monitoring and control: SCADA, Concept of modern distribution systems.
Electrical Grids and Smart Grids: Evolution of Electric Grid - Definitions, Architecture, Functions and control layer and elements of Smart Grid. Energy management system (EMS), Wide area monitoring system (WAMS) and phasor measurement units (PMU); Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering.
Solar Photovoltaic systems: Photovoltaic Cells: Operation, performance testing of cells and efficiency - PV modules, panels, string, arrays, sub array and blocking diodes. Solar Photovoltaic Systems: Configuration, Types of system stand alone and grid connected system. Solar PV system design: design consideration, process and design aid expert with AI and ML

Text Books

1. Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson
2. D P Kothari and I Nagrath, "Power System Engineering," 2/e Tata McGraw Hills, 2008
3. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-470-62761-7, Wiley
4 Konrad Mertens, Photovoltaics: fundamentals, technology and practice Chichester, West Sussex, United Kingdom: John Wiley & Sons Inc., 2014.

Reference Books

1. Mehta V K and Mehta Rohit, Basic Electrical Engineering, S Chand & Company, 2006
2. Modern Power system Analysis: D P Kothari and I J Nagrath, Tata McGraw Hill
3. James Momoh, "Smart Grid Fundamentals of Design and Analysis," Wiley, 2012
4. Kaushika, N.D, Solar Photovoltaics Technology, System Design, Reliability and Viability, Springer, 2018
5. Janaka Ekanayake Smart grid Technology and application Wiley

19EC3022 – Advance Course in Soft-Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)

L-T-P-S : 3-0-2-0 Credits : 4

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of basic search algorithms	**1,2**	**1**
CO2	Study and applications of ANN and deep learning	**2,3**	**2**
CO3	Application of various ML techniques of kMeans, kNN, SVM and GMM	**2,3**	**3**
CO4	Understand of various advance computing methods	**3,4**	**2**
CO5	Analysis and implementation of ML and genetic algorithm computing for various applications	**3,4**	**4**

Syllabus:

(i) *Advanced topics in AI*

BFS, DFS Search Techs

(ii) Bayes Rule, Logic Progg, Knowledge Systems**:** Naive Bayes, Linear Regression, Logistic Regression, Objectives of KBS, Components, Categories, Knowledge Based System Architecture

Advanced topics in ANN:

Non linear classification, Gradient Descent algorithm, Boltzmann Machine,

Recurrent Neural Networks, Associative memories, Hopfield networks Convolutional Neural Networks

Deep Learning, Deep Neural NWs:

Few Topics in ML:

Curse of dimensionality, PCA, Linear Discrimant Analysis, extensions of LDA, clustering, k-Means algorithm, Expectation Maximization algorithm Method, Vector quantitiztion, suppot vector machine, variations in SVM, Gaussian Mixture models, applications of GMMs.

Intro Other Computing Methods:

Adaptive Fuzzy Logic: Fuzzy logic and fuzzy sets: Membership functions, operations on fuzzy sets, types of fuzzy functions, Fuzzy relationships;

Genetic Algorithms: Basic Operations of a Genetic algorithm, Genetic cycles

Text Books

1 Neural Networks and learning machines, Simon Haykin, 3e, 2016.

2 MacKay, David. *Information Theory, Inference, and Learning Algorithms*. Edition;Version 7.2 (fourth printing)Cambridge, UK: Cambridge University Press, 2003.

Reference Books

[1] Bishop, Christopher. *Neural Networks for Pattern Recognition*. Edition: A Clarendon Press Publication, Oxford University Press, New York, NY,1995.

[2] Duda, Richard, Peter Hart, and David Stork. *Pattern Classification*. 2nd Edition, Wiley-Intercedence, New York, 2000.

[3] Hastie, T., R. Tibshirani, and J. H. Friedman. *The Elements of Statistical Learning: Data mining, Inference and Prediction.* New York, NY: Springer, 2001. ISBN: 9780387952840.

[4] B.Yagna Narayana,Artificial Neural networks, PHI, 2012

Web References

1 https://www.coursera.org/specializations/machine-learning

2 https://www.coursera.org/learn/machine-learning

3 https://in.udacity.com/course/machine-learning-engineer-nanodegree--nd009t

4 https://www.udemy.com/machinelearning/

PROFESSIONAL ELECTIVE COURSES

Renewable energy & Smart cities

20EC3051 –Wireless Sensor Networks & IOT Applications

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of wireless sensor network technologies.	**3/1,2**	**2**
CO2	Study of BLE protocols in WSN security and power applications.	**3/1**	**2**
CO3	Study and application of IOT and WSN for smart cities/ villages.	**3/2**	**2**
CO4	Study of various IoT application in various domains	**3,5/1**	**2**

Syllabus:

Basics of Wireless Sensor Networks: Introduction to WSN, Basic Overview of Wireless Technology, Basic Sensor Network Architectural Elements, Challenges, Applications of WSN. Some Examples of Sensor Nodes, Sensor Network Scenarios, Optimization Goals and Figures of Merit. Gateway and Router Concepts. Network Topologies: Single Hop Star, Multi Hop Mesh and Grid, Two-Tier Hierarchical Cluster.
WSN, Bluetooth & Other Protocols and Standards: Classifications of MAC Protocols for WSN, Sensor-MAC Case Study. Routing Protocols and Strategies in WSN, WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation (Optional). ZigBee/IEEE802.15.4, IEEE 802.11/a/b/g, IEEE 802.16, Bluetooth, BLE, Infrared, Differences in range, Security, Power. Bluetooth, BLE and 6LoWPAN.
IoT & Smart Cities: IoT Applications in Smart Cities, WSN for Smart Cities, WSN Design Issues for Smart Cities, Performance Metrics. Garbage Disposal, Vehicle Management, Smart Home, Smart Grid, Smart-Village. IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View
IoT Applications: Healthcare, Wearables Dairy, Agriculture, Traffic Monitoring & Control, Pollution Management, Inter-Vehicular Communication, Vehicle Tracking, Finance Transaction. Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations

Text Books

1 Kazem, Sohraby, Daniel Minoli, Taieb Zanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007

2 Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network",
John Wiley and Sons, 2005

3 Arshadeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-on Approach", Universities Press Pvt. Ltd., 2015.

Web References

1 https://www.betteru.in/course/wireless-sensor-networks-online-course-certificate/
2 https://www.udemy.com/course/complete-guide-to-build-iot-things-from-scratch-to-market/
3 https://www.youtube.com/watch?v=7h5Wwk_mheg
4 https://www.youtube.com/watch?v=-oWlS66__Qo
5 https://www.youtube.com/watch?v=m45SshJqOP4
6 https://www.youtube.com/watch?v=D3yrk4TaIQQ

20EC3052 – Solar Photo-Voltaic cells & Solar Power Arrays

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of solar photo-voltaic cell structure	**3, /1,2**	**1**
CO2	Study of basic physics and components of solar photo voltaic cells	**3/1**	**1**
CO3	Study and design of solar PV systems and testing	**3/2**	**3**
CO4	Analysis and design of SPV arrays	**3,5/1**	**3**

Syllabus:

Solar Photovoltaic Fundamentals and Characteristics: Structure, operations and characteristics of photodiode and solar cells. Photovoltaic Cells: Basic structure, materials and equivalent circuits. PV output Characteristics, performance testing of cells and efficiency. Introduction to PV modules, panels, string, arrays, sub array and blocking diodes.
Solar Photovoltaic Materials and SPV cell Production: Crystalline and amorphous silicon solar cells: Properties, production process, cells and modules, thin film solar cells, III-V solar cells, CdTe, CIGS, DSSCs, organic, hybrid and perovskite solar cells. Different techniques of solar cell fabrication and assemble: multi junction, stack (hybrid and HIT), concentrated solar cells and arrays.
Solar Photovoltaic Systems Design, Testing and Optimisation: Solar PV system design: design consideration, process and design aid expert. Performance test procedure for panels: Performance measurements, module reliability, stability and qualification testing. Voltage regulation: Grid connected structure, affine parameterization, sizing systems, feed forward control and PID controllers.
Solar Photovoltaic Arrays, Configurations and Applications: PV modules and arrays: module configuration, array topology optimization and fixed array topology. Based on SPV Application design and system reliability improvements: failure modes and effect analysis, fault tree models. Artificial Intelligence, Artificial Neural Networks and Machine Learning application for SPV systems in design reliability analysis, fault detection and fault tolerant systems.

Text Books

1. Jenny Nelson, The Physics of Solar Cells, Imperial College Press (2003)
2. Solar Photovoltaic's: Fundamentals, Technologies and Applications, C. S. Solanki, 2ndEdition, Prentice Hall of India, 2011
3. A. Freundlich, P. Verlinden, Wvan Sark, Photovoltaic Solar Energy: From Fundamentals to Applications, John Wiley & Sons Ltd. 2017.
4 Konrad Mertens, Photovoltaics: fundamentals, technology and practice Chichester, West Sussex, United Kingdom: John Wiley & Sons Inc., 2014.

Reference Books

1. Kaushika, N.D, Solar Photovoltaics Technology, System Design, Reliability and Viability, Springer, 2018
2. Reccab Manyala, Solar Collectors and Panels, Theory and Applications, Intech open, 2010
3. A. K. Mukerjee, nivedita thakur, Photovoltaic Systems: Analysis and Design, PHI Learning Pvt. Ltd., 2011
4. John Wiley & Sons, Inc, Crystalline Silicon Solar Cells, Goetzberger-Knobloch-Voss, 1998: Crystalline Silicon Solar Cells, 1998
5. Angèle Reinders, Photovoltaic Solar Energy: From Fundamentals to Applications, John Wiley & Sons, 2017
6. Weidong Xiao, "Photovoltaic Power System: Modeling, Design, and Control", Wiley, 2017

Web References

1 https://www.pveducation.org/
2 http://www.alternative-energy-tutorials.com/solar-power/photovoltaics.html
3 https://www.nrel.gov/research/re-solar.html
4 http://www.fsec.ucf.edu/en/consumer/solar_electricity/index.htm
5 https://nptel.ac.in/courses/115107116/
6 https://www.open.edu/openlearn/nature-environment/environmental-studies/energy-resources- solar-energy/
7 https://www.coursera.org/learn/photovoltaic-solar-energy/

20EC3053 – Electronic Systems for Renewable Energy & Smart Grid

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of renewable energy electronics	**3/1,2**	**1**
CO2	Study and analysis of electronics systems for renewable energy sources	**3/1**	**2**
CO3	Analysis and study of smart grid sub-systems and circuits	**3/2**	**3**
CO4	Analysis of electrical smart grids	**3,5/1**	**3**

Syllabus:

Introduction to Renewable Energy Sources: Introduction to Renewable Energy, Types of Renewable Energy, Solar power, solar resource, hybrid systems, wind resource and wind firm, Electronic Power Converters in Wind Turbines and Solar Photo voltaic Systems.

Electronics Systems for Renewable Energy Sources: Grid Monitoring and state estimation: Introduction, method of state estimation, algorithms for state system, sensors for grid monitoring: feeder sensors for SCADA, distributed energy resource sensors, metering sensors, portable and temporary sensors, Managing Data: meter data management, smart metering rollout, delivering bill-ready meter data.

Smart Grid Sub-systems and Circuits: Asset management and conditioning monitoring, smart grids and condition monitoring, Reliability indices: Introduction to distribution system reliability, reliability assessment with distribution automation: Fault indicator DA scheme, DA scheme using sequential coordinated re-closers, automated smart load restoration DA scheme.

Electrical Smart Grids: Smart customer and smart Home, From Smart Grid to Smart cities to IOT: opportunity, looking to future. Enhancing smart grid stability with the implementation of heuristic algorithms. Advanced metering infrastructure, Smart grid cyber security, Smart grid communications, Restructuring of power systems.

Text Books

1 Vaughn Nelson, “Introduction to Renewable Energy” CRC Press, 1st edition, 2011.

2 Ahmad Hemami, “Electricity and electronics for renewable energy technology: an introduction”,Taylor & Francis,2016

Web References

1 https://nptel.ac.in/courses/117108141/

2 https://onlinecourses-archive.nptel.ac.in/noc18_ee42/preview

3 https://www.youtube.com/watch?v=2XWIiS6M_-g

4 https://www.youtube.com/watch?v=AbNXbLm4iUs

5 https://www.youtube.com/watch?v=JwRTpWZReJk

6 https://www.youtube.com/watch?v=Ft8nAo5hzdQ

20EC3054 – IOT Applications for Smart Cities

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of smart cities/villages/living	**3/1,2**	**2**
CO2	Study of systems for smart cities with case studies.	**3/1**	**2**
CO3	Analysis and design of smart grid sub-systems and circuits	**3/2**	**4**
CO4	Study of advanced topics related to privacy, scaling and design considerations.	**3,5/1**	**2**

Syllabus:

Introduction to Smart Cities, Smart Villages and Smart Living:

- Characteristics of Smart Cities- Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, Smart Living.
- Introduction to IoT and Architecture, Introduction to IoT for Smart Cities.
- IoT based solutions for Smart Cities – Smart Grid, Smart Home, Transport and Traffic Management, Smart Healthcare.
- Challenges- Planning, Cost and Quality, Security and Privacy, Risks,
- IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Systems for Smart Cities:

- World’s Examples- International and National Case Studies.
- Network Infrastructure for Smart Cities, Emerging Technologies, Challenges and Concerns.
- Systems for Smart Cities: Smart Grid, Smart Vehicle Tracking, Security, Traffic, Pollution, Smart Home, Advanced Safety & Security Systems, Smart Water Management, Smart Waste Management, Smart Buildings, Smart Mobility, Smart Economy, Smart Environment, Smart Energy and Healthcare.
- IoT Systems Design Methodology for Smart Cities Applications.
- ICT for Smart Cities - ICT Architecture, Major Technology Areas, ICT Systems for Smart Cities.

Designing IoT Systems for Smart Cities:

- Designing Systems for: Home Automation, Street Lighting, Advanced Safety & Security Systems, Garbage Disposal, Vehicle Management, Smart Home, Smart Money.
- IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT.

- Miscellaneous Topics: Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry.

Design Considerations, Economics and Issues in IoT Applications:

- IP Protection, Security, Privacy and Scaling issues in IoT for Smart Cities.
- Trust in IoT-Data-Platforms for Smart Cities.
- First Steps Towards a Secure Platform, Data Aggregation for the IoT in Smart Cities.
- Design Considerations, Economics.
- Introduction to M2M to IoT, M2M Value Chains, IoT Value Chains, M2M to IoT-An Architectural Overview.

Text Books

1 Ejaz, Waleed, and Alagan Anpalagan. Internet of Things for Smart Cities: Technologies, Big Data and Security. Springer International Publishing, 2019.

2 P P Anil Kumar, Introduction to Smart Cities, Pearson India; First edition, 2019.

3 Michael Miller, "The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", Pearson Education, 2015.

REFERENCE BOOKS:

1 Arshadeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-on Approach", Universities Press Pvt. Ltd., 2015.

2 Stan McClellan, "Smart Cities in Application: Healthcare, Policy and Innovation", Springer.

3 Schahram Dustdar, "Smart Cities: The Internet of Things, People and Systems", Springer, 2017.

WEB REFERNCES:

1 IoT-From Research and Innovation to Market Deployment_IERC_Cluster_eBook_978-87-93102-95-8_P.pdf

MOOCS:

1 https://www.coursera.org/specializations/developing-industrial-IoT

2 https://www.coursera.org/learn/smart-cities

20EC3055 – Systems for Smart Cities & Smart Villages

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study of smart cities/villages and sub-systems	**3/1,2**	**2**
CO2	Study of systems for smart villages.	**3/1**	**2**
CO3	Study of smart systems for smart cities.	**3/2**	**2**
CO4	Study of advanced topics and case studies related to industrial systems and global systems.	**3,5/1**	**2**

Syllabus:

Introduction to Smart Systems: Characteristics of smart systems, Development and challenges of smart systems, Type of Smart Systems, Definition of Smart Cities, Smart Villages and Smart Living, Sub-Systems: Local requirements, Issues and Solution.

Systems for Smart Villages: Architecture of Smart Village System, Modules for Smart Village, Ration Management system, Notification Management system, Milk Dairy Management system, Labor Management system ,Tax Payment system and Smart Agriculture management System, Introduction to Broad-band, Wi-Fi, Crop Price, Commodity Price, e-Governance privacy and security.

Systems for Smart Cities: Architecture of Smart cities System, Modules for Smart Cities, Data Aggregation of Smart Cities and Security, Future Industry concept, Oil and Gas Industry, Home Management and e-Health. Smart Water/Electricity Billing, Energy Saving, Smart Grid, Smart Waste Management, Parking, Traffic Management, Policing, Monitoring, Pollution Control etc.

Next Generation Smart Systems: System of Smart Systems, Connected and Autonomous Vehicle Data Ecosystem , Topology of Data Ecosystems , Directed data ecosystems, Acknowledged data ecosystems, Collaborative data ecosystems, Virtual data ecosystems, Incrementally Evolving Systems Engineering: Cognitive Adaptability, Smart Industrial Systems, World's Smart Cities, Global Systems

Text Books

1 Schahram Dustdar, "**Smart Cities: The Internet of Things, People and Systems**", Springer, 2017.

Web References

1 https://nptel.ac.in/courses/106105166/47

2 https://1000projects.org/online-smart-village-monitoring-system.html

3 https://www.youtube.com/watch?v=LlhmzVL5bm8&list=PL9ooVrP1hQOGccfBbP5tJWZ1hv5sIUWJl

4 https://www.youtube.com/watch?v=Br5aJa6MkBc

5 https://www.youtube.com/watch?v=m45SshJqOP4

6 https://www.youtube.com/watch?v=D3yrk4TaIQQ

VLSI

20EC3061 – Low Power VLSI

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the physics of power dissipation including short circuit power, dynamic power and leakage power, techniques that makes a low power circuit and introduction to simulation power analysis.	**1,2/1**	1
CO2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits.	**1,2,3/1**	2
CO3	Apply low power techniques at gate level, architecture level and system levels.	**1,2,3/2**	2
CO4	Illustrate essential tasks in algorithm and architecture level low power design environments and Apply low power clock tree distribution techniques to create low power devices.	**1,2/1**	2

Syllabus:

Low Power CMOS VLSI Design: Sources of Power Dissipation, Static and Dynamic Power Dissipation, Active Power Dissipation, Designing for low-power, Circuit techniques for leakage power reduction.

Simulation and Power Analysis: SPICE circuit Simulation, Discrete Transistor Modelling and Analysis, Gate level logic simulation, architecture level analysis, Date correlation analysis in DSP systems, monte carlo simulation. Random Logic Signals, Probability and Frequency, Probabilistic power analysis techniques, signal entropy.

Low Voltage, Low Power Adders and Multipliers: Standard Adder cells, CMOS Adder's architectures, Bi-CMOS Adders, Low-voltage, Low-power design techniques, Current-mode adders. Low Voltage Low-Power Multipliers Introduction, Overview of Multiplication, Types of Multiplier Architectures, Booth Multiplier, Wallace Tree Multiplier.

Low-Voltage, Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM

Text Books

1 Kiat-Seng Yeo, Kaushik Roy, Low-Voltage, Low-Power VLSI Subsystems –TMH Professional Engineering.

2 Gary K. Yeap, Practical Low Power Digital VLSI Design –Kluwer Academic Press, 2002.

Reference Books

1 Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic.

2 Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley.
3 Yeo, “CMOS/BiCMOS ULSI Low Voltage Low Power” Pearson Education.

20EC3062 – Algorithms for VLSI Design Automation

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the VLSI design methodologies and design rules.	**1/1,2**	1
CO2	Analyse the basic concept of floor planning, routing and simulation.	**2/1**	2
CO3	Study of the modelling process.	**1,3/2**	2
CO4	Study of the synthesis process including FPGA and automation of MCMs.	**1,3,6/1**	2

Syllabus:

Introduction to VLSI Design & Algorithms: Complexity Issues and NP-hardness, Basic Algorithms, Basic Data Structures, Graph Algorithms for Physical design. Partitioning: Classification of Partitioning Algorithms, Group Migration Algorithms, Simulated Annealing and Evolution, Other Partitioning Algorithms. Computational complexity, Design automation tools.

Floor Layout and Modelling: Floor planning, Chip planning, Pin Assignment. Placement: Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algorithms, Modelling

Hardware Models and Routing: Classification of Routing Algorithms, Global Routing, Maze Routing Algorithms, Line-Probe Algorithms, Shortest Path Based Algorithms, Steiner Tree based Algorithms, Single-Layer Routing Algorithms, Two-Layer Channel Routing Algorithms, Three Layer Channel Routing Algorithms Multi-Layer Channel Routing Algorithms, Switchbox Routing Algorithms. Scheduling Algorithm, High Level Transformations.

FPGA Technologies: Physical Design Cycle for FPGAs, FPGA Architecture and PIN Diagram, Physical Design Automation of MCMs: MCM Physical Design Cycle, Partitioning, Placement, Routing.

Text Books

1 Naveed Sherwani, “Algorithms for VLSI Physical Design Automation” 3rd edition, Springer International Edition.
2 S.H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley 1999.

Reference Books

1 Hill & Peterson, “Computer Aided Logical Design with Emphasis on VLSI” Wiley,1993.
2 Wayne Wolf, “Modern VLSI Design: Systems on silicon” Pearson Education Asia, 2nd Edition.

20EC3063 – ASIC & FPGA Chip Design

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study and design of combinational and sequential circuits using PLDs and state machines.	**1, 3/1**	2
CO2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	**3, 11/1**	2
CO3	To study PLD structures and design process. Study of different CPLD and FPGA architectures	**1, 3/2**	2
CO4	To understand different physical process.	**3,11/1**	2

Syllabus:

Programmable Logic Design: Combinational Logic: PLDs – ROM, PLA, PAL. Analysis of Clocked Sequential Circuits: State table, State diagram, State Equation, State reduction, state Assignment. Flip Flop Excitation Tables, Design Procedure. Verilog Programming.

ASIC Design: Full Custom Design; Semicustom Design; Standard Cell Based ASIC, Gate Array Based ASIC, Programmable Logic Devices, CPLDs, FPGA, ASIC Design Flow, Economics of ASICs, ASIC Cell Library. Programmable ASICs: The Antifuse, Static RAM, EPROM and EEPROM. MOS Programmable Logic Device (PLD).

Programmable Logic Devices: Sequential PLD; Complex PLD; Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Complex Programmable Logic Devices (CPLDs): Introduction, Altera Series- MAX 5000/7000, FLEX Logic 10000, AMDs – CPLD (Mach 1 to 5), Cypress FLASH 370 Device technology.

Designing Arithmetic Building Blocks: Introduction, The Adder: Definition, Circuit and Logic Design, The Multiplier: Definition. The Shifter: Definition. Memories, ROM, ROM architecture, types of ROM, applications. RAM, RAM Architecture, static & dynamic RAM.

Text Books

1 Michael John Sebasatian Smith, "Appliction Specific Integrated Circuits" Pearson Education.

2. M. Morris Mano, "Digital Logic and Computer Design", Pearson.

3. Debaprasad Das, "VLSI Design", Oxford – 2011.

Reference Books

1. Bob Zeidman, "Designing with FPGAs and CPLDs", CMP Books, ISBN: 1-57820-112-8.

2. Stephen Brown and Zvonko Vranesic "Fundamentals of Digital Logic with Verilog Design" McGraw-Hill.

3. Pak K. Chan, Samiha Mourad, "Digital Design Using Field Programmable Gate Array", Pearson Education – 2009.

20EC3064 – VLSI Sub-system Design and Design for Testability

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the different design and programmable design techniques.	**1,3/1,2**	1
CO2	Analyse different memory and array subsystems.	**1,3/1**	2
CO3	Analyse the fault tolerant system can be viewed as a design moving through different abstraction levels, a historical view of the development of VLSI system.	**1,3/2**	2
CO4	Examine The test pattern generation for BIST and specific BIST architectures.	**1,3,5/1**	2

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell-based design; full custom design; Design flow; Design Economics. Data path Subsystems: Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off.

Memory and Array Subsystems: SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories. Special purpose Subsystems: Packaging; power distribution; I/O pads.

Fault Tolerant Design: Importance of fault tolerance, Basic concepts of fault tolerance, Static redundancy, schemes of fault redundancy, Time redundancy, Software redundancy, Fail-Safe Operation, Fault table method, kohavi algorithm, Path sensitization, Boolean difference.

Design for Testability: ATG for SSFs in combinational and sequential circuits, Detection of bridging faults, Functional fault testing models, Ad Hoc design and design for testability techniques, Generic scan-based designs, some advanced scan concepts, BIST architectures.

Text Books

1 Neil H. E. Weste, David. Harris and Ayan Banerjee, "CMOS VLSI Design" - Pearson Education, Third Edition, 2004.

2 Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, "Digital Systems Testing and Testable Design" Revised Printing, IEEE Press, New York.

Reference Books

1 Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" Pearson Education, Second Edition.

2 P. K. Lala," Fault Tolerant and Fault testable hardware design", BS Publication

3 Michael L. Bushnell &Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers. 2000.

4 N.N.Biswas "Logic Design Theory" PHI.

20EC3065 – Semiconductor Memories & MEMS

L-T-P-S : 3-0-0-0 Credits: 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyse the different memory and array subsystems	**1,2/1**	1
CO2	Study of nanoelectronics based ferroelectrics and solar cells	**1,3/1**	2
CO3	Study of various MEMS and NEMS materials and applications.	**1,3/2**	2
CO4	Understand the basic concept reliability and modeling of faults as a requisite for achieving manufacturing quality of semiconductor devices and then identifies difficulties in VLSI testing.	**1,3/1**	2

Syllabus:

Basics of Semiconductor Memories: Memory Architectures and building blocks, Static RAMs and Dynamic RAMs. Basics of SRAM cell, CMOS SRAM cell, design of CMOS SRAM cell, READ and WRITE operations. Basics of DRAM, differential operation in dynamic RAMs, READ and WRITE operations, area considerations. Peripherals of SRAM. Non-volatile Memories: Memory timing definitions, Memory architecture, Masked Read Only Memories (ROMs)- Programmable Read Only Memories (PROMs), Erasable (UV) Programmable Read only Memory (EPROMs) Electrically Erasable PROMs (EEPROMs), Content Addressable Memory (CAM), Programmable Logic Array.

Nanoelectronics based Ferroelectrics and Solar cells: Nanoelectronics, Moors Law, Quantum phenomena for Nanoelectronics, Quantum dots, Nano ferroelectrics, Magneto resistive random-access memory (MRAM), DRAM Circuit operation Principle, Memory Peripheral Circuitry: The address decoders, sense amplifiers, voltage references, drivers/buffers, Timing and Control. Basic principle of capacitor and Super Capacitor, Types of Super Capacitor, Super Capacitor energy storage mechanism, Photons, Photo Voltaic Effect, PEC Solar cells, Types of solar cells, Dye sensitized and organic solar cells.

Overview of MEMS and NEMS: Materials for MEMS: Semiconductors, Metals and Metal alloys, Ceramics, Polymers, Silicon and other substrate materials. Introduction to Micro-Nano fabrication: Cleaning, Oxidation, Diffusion, Mask making, Lithography, Etching, Ion Implantation, CVD, PVD, Metallization; Surface micromachining and Bulk Micromachining, DRIE, LIGA, Fabrication of high aspect ratio deformable structures. Mircosensors and Microactuators: Optical, chemical, thermal, gas, pressure, bio and mechanical sensors, Nanosensors.

Design for Testing and Misc. Topics: Basics of Testing: Fault models and fault simulation, Test generation for Combinational Circuits. Current sensing-based testing. Classification of sequential ATPG methods. Fault collapsing and simulation. CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis. Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing. Reliability, Yield and Power dissipation in Memories. Signal to Nosie ration, Memory yield, sources of power dissipation in memories, partitioning of the memory, Addressing the active power dissipation. Semiconductor memory trends and evolutions.

Text Books

1 Tai-Ran Hsu, MEMS and Microsystems – Design, Manufacture, and Nanoscale Engineering, Second Edition, John Wiley & Sons, Inc., New Jersey, 2008.
2 Reza Ghodssi, Pinyen Lin, MEMS Materials and Processes Handbook, Springer, New York, 2011.
3 Introduction to Nanotechnology – Charles P.Poole Jr and Frank J.Owens .,Wiley India Pvt.Ltd.,2007.
4 Nanotechnology and Nanoelectronics – W.R.Fahrner .,Springer., 2006
5 N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.
6 W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann, Publishers. 2006.

Reference Books

1 H. Baltes, O. Brand, G. K. Fedder, C. Hierold, J. G. Korvink, O. Tabata, Enabling Technology for MEMS and Nanodevices, Wiley-VCH, Weinheim, 2004.
2 C.P. Wong, Kyoung-Sik (Jack) Moon, Yi Li, Nano-Bio- Electronic, Photonic and MEMS Packaging, Springer, New York, 2010.
3 Sandra Carrara, Nano-Bio-Sensing, Springer, New York, 2011.

20EC3066 – Analog & Digital, IC Design and Applications

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the functionality and Electrical Properties of MOS Devices. Understand concept of various amplifiers.	**1,3/1,2**	2
CO2	Analysing and design of passive & active current mirrors and switched capacitor technique.	**1,3/1**	2
CO3	Illustrate the design procedure of static and dynamic CMOS circuits. Illustrate the design procedure of sequential logic gates and clock synchronization.	**1,2,3/2**	2
CO4	Discuss the design procedure of arithmetic building blocks and memories.	**1,2,3/1**	2

Syllabus:

Amplifiers: MOSFET basics, large and small signal models of MOSFET, second order effects (such as, channel length modulation, Substrate bias effect). Single Stage (CS, CG, CD) amplifiers, single stage amplifiers with different loads, Cascode Stage, Differential and Operational-Amplifiers.

Current Mirrors and Switched Capacitor Technique: Introduction of MOS Current Mirrors and types. Basic MOS Current Mirrors, Cascode current mirror, Switched-capacitor technique, Filter realization using switched capacitor technique.

Designing Combinational and Sequential Logic Gates in CMOS: Introduction, Static CMOS Design, Dynamic CMOS Design, Static Sequential Circuits Dynamic Sequential Circuits, Timing Issues in Digital Circuits**:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization.
Designing Arithmetic Building Blocks: Introduction, The Adder: Definition, Circuit and Logic Design, The Multiplier: Definition. The Shifter: Definition. Memories, ROM, ROM architecture, types of ROM, applications. RAM, RAM Architecture, static & dynamic RAM.

Text Books

1 BehzadRazavi, "Design of Analog CMOS Integrated Circuits", Tata Mc Graw Hill, (2005)
2 S. Kang and Y Leblebici, "CMOS Digital Integrated Circuit" Tata Mc Graw Hill, (2005), 3rd edition.
3 Jacob Baker, "CMOS Mixed Signal Circuit Design", John Wiley, (2008)
4 Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003

Reference Books

1 Neil H. E. Weste and David. Harris Ayan Banerjee, "CMOS VLSI Design" – Pearson Education, 1999.
2 Gray& Mayer, "Analysis & Design of Analog Integrated Circuits", 4th edition, Wiley, (2001).

Robotics & Automation

20EC3071 – Control Systems & Introduction to Robotics

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Classify various types of robotic configurations	1,2/1	2
CO2	Select appropriate type of drive, gripper and sensor for Robot	1,2/1	3
CO3	Recommend appropriate robot configurations for various applications.	1,2	3
CO4	Understand various implementation issues for robotics	1,2	2

Syllabus:

***Control System Basic Concepts*:**

Basics: Terminology, Examples, Open Loop, Closed Loop Control Systems, Types of control systems, Errors, Error Margins. Mathematical Models of physical systems: Formulation of Differential equations for Transfer Functions of DC & AC Servomotors.

Block diagram of control systems; Signal flow graph, Mason's gain formula.

***Time and Frequency Domain Analysis*:**

Standard Test *signals* – Step, Ramp, Parabolic and Impulse; Impulse Response.

Characteristic Equation of Feedback systems, Transient Response of First order and Second order Systems, Steady state error and Error constants. Introduction to *PID* and *PID Controllers Stability analysis:* Concept of stability and conditions for stability, Routh – Hurwitz criterion (optional), dominant poles of *transfer function*. *Root Locus Technique:* Root Locus concept, basic properties, magnitude and angle conditions, effects of adding poles and zeros to G(s) H(s). *Frequency response*: Specifications, correlation, Bode-plot, phase margin, gain margin.

***Introduction of Robotics*:**

Types of robots, Classification, usage, and the diverse *Applications* of Robots.

Mathematical Representations of Robots: Position and orientations of rigid body, Homogeneous transformations, Representation of joints, Link representation using D- H parameters. Different kinds of *Actuators:* Stepper, DC servo and AC motors

Different Types and Ranges of *Sensors:* Internal and External sensors.

Common Sensors – encoders, tachometers, strain gauge-based force-torque sensors, proximity and distance measuring sensors

***Kinematics, Dynamics Motion Planning and Control*:**

Kinematics: for Robotic Arm and Robots, Planning of Manipulator Trajectories, Control and Kinematics, Serial and Parallel manipulators, Direct and Inverse Kinematics.

- *Degrees of Freedom & Dynamics:* Parallel mechanisms, Constraint equations, Velocity and Static Analysis, Formulation of Equations of Motion, Recursive Dynamics.
- *Simulations* of robots using MATLAB / PHYTHON.
- *Robot Control Techniques*, Position and Force Control, Modeling

and Control of
Robots. Design of slip-free Wheeled Mobile robots.

- *Advanced Topics in Robotics:* Nonlinear dynamics, Chaos HMI, BMI
and Humanoid.

Text Books

1 J. Nagrath & M Gopal, "Control System Engineering", 5th Edition, New Age International Publication, New Delhi (2011).

2 B. C. Kuo," Automatic Control Systems", Eighth Edition, Prentice Hall India Publications, New Delhi , (2010).

3 A. Ghosal, "Robotics: Fundamental Concepts and Analysis", Oxford University Press, 2nd reprint, 2008.3.

4

5 1. J. Nagrath & M Gopal, "Control System Engineering", 5th Edition, New Age International

6 Publication, New Delhi (2011).

Reference Books

1 K Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall India Publication, New Delhi , (2010).

2 M. Gopal, "Control Systems Principles and Design", Fourth Edition, Tata Mc-Graw Hill Publications, (2012).

3 K. Fu, R. Gonzalez, and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw - Hill, 1987.

20EC3072 – Autonomous Vehicles & Automotive Electronics

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Autonomous Vehicles, dynamics and design electronics to complement those features.	1,2/1	2
CO2	To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms. To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software	1,2	3
CO3	To understand the concepts of Automotive Electronics and its evolution and trends. Automotive systems & subsystems overview	1,2/1	3
CO4	Design and implement the electronics that attribute the reliability, safety, and smartness to the embedded to Automotive Electronics protocols and autonomous Vehicles testing, vibration.	1,2	2

Syllabus:

(i)Introduction to Autonomous Vehicles [4-5]

Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Vehicle Operating Software; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Society of Automotive Engineers Levels of Automation; Major Functions of physical Ecosystem of an Autonomous Vehicle (cameras, radar, lidar, gps, ultrasonic sensors, central computer, DRSC-based Receiver); Autonomous Vehicle architecture (JAUS & GOA);

(ii) Driver Assisted/Driverless Vehicles, Connected Vehicles: [4-5]

Basic control system applied to Drive Assisted, Driverless, Connected Vehicles; Overview of the operation of Electronic Control Unit (ECUs); Basic cyber-physical system theory and autonomous vehicles; Comparison chart of deriver assisted vs driverless vehicle and connected Vehicles vs Autonomous Vehicles.

Automotive Sensors [4-5]

Role of sensors and actuators in autonomous vehicles; Schematic principle of Autonomy and automotive sensors; Sensor characteristics**,** Hall phase, Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Exhaust gas oxygen concentration, Throttle plate angular position, Crankshaft angular position/RPM, Manifold Absolute Pressure (MAP), Differential exhaust gas pressure and Air bag sensors, Sensor Testing and Calibration **Automotive Actuators (AA) :** Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Transmission (AT) [4-5]: Transmission fundamentals, Types MT, AT, CVT and DCT, ATS, Clutch, characteristic studies of Gear Box, epicyclic gear arrangement. **Microcontrollers for Automotive (AM):** Criteria to choose the right microcontroller/processor for various automotive applications; Understanding various architectural, Dynamometer testing. Vehicle Control, Power train, Driver Information, Motor Control Technologies: Toshiba offers microcontrollers, Vector Engine (VE), Automotive MCU

Automotive Control System & Model Based Development [1-2]: Control system approach in Automotive Electronics, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE toolboxes.

Automotive Electronics (AE) [4-5]

Fundamentals of Automotive Electronics (FAE): Principles of automotive systems **Advanced driver-assistance systems (ADAS):** Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, ADAS in Toyota, Nissan, Honda, Hyundai, Volkswagen, BMW, General Motors. **Bluetooth low energy and the automotive (BLE-AE):** Functional view of BLE; BLE-enabled Vehicle access block diagram; operation of Smart vehicle access using BLE, Driver assistance and personalization using BLE-AE, Piloted/assisted/remote parking BLE-AE.

Automotive Wireless (AW)[4-5] : Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Wireless

Access in Vehicular Environments (WAVE) amendment to IEEE 802.11; IEEE 802.11ac WLAN PHY and dual-band (2.4 GHz/5 GHz) support ; EEE 1609 - Family of Standards for Wireless Access in Vehicular Environments (WAVE). **Automotive GPRS Vehicle Tracking (AGPRS-VT)** Vehicle Tracking System; Principle of working for Vehicle Tracking system. GPS and GPRS tracking system

Embedded to Automotive Electronics and autonomous Vehicles [4-5]:

Controlled Area Network (CAN): Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication. **Local Interconnect Network (LIN) :** Basic, LIN workflow concepts, LIN frame, header concepts, IN Checksum Calculation and Verification, applications.

FlexRay Consortium [5-6]: Basics, Working, Clock synchronization, Single Edge Nibble Transmission) protocol: SENT protocol structure, Basic Concepts and Fast Channel Data Transmission, **Media Oriented Systems Transport (MOST):** Principles of communication operations, Competing standards. **Vehicle Area Network (VAN):** basic architecture of VAN, operational view of VAN, Integrated to Automotive Electronic Protocols: EBD, Electronics stability programs (ESP), PA Industrial control system protocols: Open Platform Communications (OPC), Remotely Piloted Vehicles (RPVs); Unmanned Aerial Vehicle (UAV). **Manifold Absolute Pressure Sensor (MAP sensor):** Basic architecture, operation, applications, testing procedure of MAP. Electronic Control Units (ECU), Vehicle Networking & Diagnostics Stacks; Automotive Functional Testing: The Process Flow-diagram. HIL Testing, MIL Testing, SIL Testing.

Text Books

1. Crating Autonomous Vehicle Systems by shaoshan liu, liyun li
2. Autonomous vehicles: opportunities, Strategies, and Disruptions by Michael McGrath
3. Reinventing the automobile: personal urban mobility for the 21st century (the MIT Press) by William J. Mitchell, Chris E. Borroni-Bird, Lawrence D. Burns.
4. Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System” Prentice Hall Inc., New Jersey
5. Understanding Automotive Electronics an Engineering Perspective Seventh edition William Ribbens.
6. Automotive Power Transmission Systems Yi Zhang University of Michigan-Dearborn USA Chris MiSan Diego State University USA.
7. Automotive Embedded Systems Handbook CRC Press Taylor & Francis Group Richard Zurawski
8. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive Robert Bosch GmbH (Ed.) 5th Edition
9. William B Ribbens "Understanding Automotive Electronics", SAE Publications, 1998
   Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006.
10. Marc E. Herniter and Zac Chambers: “Introduction to Model Based System Design”, RoseHulman Institute of Technology. Rudolf Limpert, “Brake design and Safety”. SAE Publications, 2015,

Web References

1 https://toshiba.semicon-storage.com/ap-en/product/automotive/micro.html
2 https://www.tesla.com/autopilot
3 https://www.audi.com/en/experience-audi/mobility-and-trends/autonomous-driving.html
4 https://global.toyota/en/mobility/
5 https://www.mazdausa.com/

20EC3073 – Advanced Robotics

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	The objective of Advanced Robotics is an in-depth study in robot sensing; actuation; communications; control; computer vision; and path/motion planning	1,2/1	2
CO2	Understanding of Advanced Robotic Manipulator & Actuator (ARM & ARS), Design and analysis on Advanced Robotics Modelling.	1,2	3
CO3	To understand Advanced Level of Robotics, Depth understanding on the functional and critical operational view of Advanced Robotics	1,2/1	3
CO4	The objective is to study all the advanced robotics systems, Real time Environmental, application in manufacturing processes, casting, welding, painting. Understanding present advanced model and applications.	1,2	2

Syllabus:

Introduction to Robotics (ITR): [3-4]
Brief History, Types of Robots; Technology of Robots, Basic Principles in Robotics; Mathematical Representation of Robots; Robot Hardware; Obstacle Avoidance, Task Planning and Navigation; Robot Vision; Artificial Intelligence Applications of real-world Environments (Driverless, Unmanned Aerial Vehicles (UAV), and Tele-robots), Introduction to Robotic Operating System (ROS)

Robotics Foundation: [4-6]
Degrees of Freedom (DoF), Six Degrees of Freedom (6DOF), Mobility formula, Three Laws of Robotics; Asimov's Laws(AL), Dynamic Stabilization(DS), Advanced Robotics Sensors(ARS), Power Sources(PS), Force Control(FC), Ring LASER, Gyro Sensor(GS), Inertial Navigation(IN), Terrain a Mapping (TaM), Contour following direct and inverse kinematics problems and workspace,Kinematics. Motions and dimensions; Robotics Components, Power, types of Robot Sensors.

Advanced Robotic Manipulator & Actuator (ARM & ARS) [8-10]:
Industrial Robot Manipulator: Manipulator Structures, Kinematics of Serial and Parallel Manipulators, Velocity Analysis and Statics of Manipulators, Dynamic of Manipulators, Trajectory Planning and Generation(P&G), position and Force control of Manipulators, Modelling and Control of Flexible Manipulators, Modelling and analysis of Wheeled Mobile Robot; 3D LASER Doppler Vibrometer, Magnetic Levitation Control, Inverse Kinematics solution for general 6R manipulator. Joint Actuating System; Servomotor; Grippers, AR in Path Planning Algorithm, Hill-Climbing, Design Consideration Macrobiotics.

Varieties of Robots & Advanced Robotics Heterogeneity (ARH) [8-9]: Design Studies on Boston Dynamics Products: Cheetah, Atlas, SpotMini, Legged Robots, Wheeled Robots, Mobile Robots, Telerobots, Service Robots; Design considerations On: Large Robots, Miniature Robot(Swarm robotics), Auto-bots, Swarm-Robotics, Micro-bots, wheeled mobile robots, bipeds,KUKA Collaborative Robot Serie, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots, Introduction to Autonomous Electric Vehicles(AEVs).

Case Studies, Applications & Humanoid [8-10]:

[i]: Robot Assembling: Assembly of robots using Lego, Vex and Tetrix Kits – Five-minute bot, Line follower, Obstacle avoidance robot, Wall following robot; Coordinated Multi-Robot Exploration; Mapping and Localization in Non-Static Environments.

[ii]: Programming: Programming of robots using NXT software, Robot C and python programming -advanced path planning robots. **e-Yantra Firebird Kit**: Introduction, Architecture, programming using Atmel studio, Programming: Buzzer, Line following, LCD display.

[iii]: Case Studies: Multiple Robots, medical robots: image guided surgical robots, radiotherapy, cancer treatment.

[iv]: Miscellaneous Applications: Industrial /Home/Defense Applications, painting robots, image guided Surgical Robots (SR], Cancer Treatment Robot (CTR)

Textbooks

[1]. Industrial Robotics Technology, Programming and Applicationsby M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey
[2]. Ashitava Ghosal - Robotics - Fundamental concepts and analysis-Oxford University Press (2006)
[3]. Anis Koubaa, Hachemi Bennaceur, Imen Chaari, Sahar Trigui, Adel Ammar, Mohamed-Foued Sriti, Maram Alajlan, Omar Cheik hrouhou, Yasir Javed Series: Studies in Computational Intelligence Publisher: Springer, Year: 2018ISBN: 978-3-319-77042-0,978-3319770406
[4]. Springer Tracts in Advanced Robotics Volume 55 Editors: Bruno Siciliano · Oussama Khatib · Frans Groen

Reference Books

[1]. Mikell P Groover, Automation, Production Systems, and computer integrated Manufacturing‖, Prentice Hall, 2001.
[2]. Introduction to Roboticsby S. K. Saha
[3]. Introduction to Robotics–Analysis Systems, ApplicationsbyS. B. Niku.
[4]. Robotics: ―Fundamental Concepts and Analysis by A. Ghosal
[5]. Industrial Robot Programming–Building Application for the Factories of the Future by Pires
[6]. Image Guided Interventions – Technology and Applications‖, Springer by Peters

20EC3074 – Computer Vision & Applications

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Implement fundamental image processing techniques required for computer vision.	1,2/1	2
CO2	Apply Hough Transform for line, circle, and ellipse detections	1,2	3
CO3	Apply 3D vision techniques. Implement motion related techniques; develop applications using computer vision techniques.	1,2/2	3
CO4	Understands motion analysis. To study some applications of computer vision algorithms.	1,2/1	2

Syllabus:

Introduction to Computer Vision (CV)

Basic Block Diagram Computer Vision; Principle of Computer Vision; Perception of 2 Dimensional & 3Dimensional Transformation (2DCVT &3DCT); 3D Rotation; Histogram, Texture Analysis;, Image formation, Geometric Primitives and transformations, Geometric Primitives, 3D to 2D Projections, Lens distortions, Color, Compositing and matting, Point, Pixel transforms, Histogram equalization, Application: Tonal adjustment, 4D to 11D Transformation on CV.

Optical Features Extraction (OFE)

Overview of Feature Extraction on Computer Vision ; Edges, HOG, SIFT, SURF, DTW, Gabor Filter, Scale Space Analysis; Analysis Edges, Edge detection , Edge linking , Application: Edge editing and enhancement ,A comparative study of CFs, LBP, HOG, SIFT, SURF, and BRIEF for security and face recognition , Gabor filter for image processing and computer vision.

Video Features & CV Methods

Optical Flow, Optical Flowrate, Elastic Band, Boundary Detection.

Optical Flow-Rate ,Optical Flow Estimation,Ealstic Band ,Selection of Terminal Point of the Line, Texture Segmentation, Edge Flow and Anisotropic Diffusion, Edge Flow Definition ,Edge Flow Intensity ,Edge Flow Texture, Edge Flow , Edge Flow Based on Gabor Phase , Edge Flow Integration , Edge Flow Propagation and Boundary Detection.

Pattern Analysis-Dimension Reduction

VQ, ICA, KNN, PCA, LDA, Classifiers: GMM, SVM, CNN, DNN Gaussian Mixture Model and Deep Neural Network Recognizing faces with PCA and ICA, K-nearest Neighbors (KNN) ,Classification Model LDA in Python for Computer Vision ,LDA in Python for Computer Vision, Deep Learning for Computer Vision, Support Vector Machines (SVM), Image Processing with the Computer Vision API vision field, LDA in Python for Computer Vision, Robust Principal Component Analysis for Computer Vision, Diagnosis and Treatment of Computer Vision Syndrome, Image Classifier using CNN.

Text Books

1 Ayman Al Falou -Advanced Secure Optical Image Processing for Communications APRIL 2008
2 Richard Szeliski- Computer Vision: Algorithms and Applications March 30, 2008

References

3 Noah Snavely's - Introduction to Computer Vision class at Cornell Tech (Spring 2019)
4 Bharath Hariharan's - Computer Vision class at Cornell (Spring 2019)
5 Pascal Fua's - Introduction to Computer Vision class at EPFL (Spring 2019)
6 Ioannis Gkioulekas's - Computer Vision class at CMU (Spring 2019)
7 Ioannis Gkioulekas's - Computational Photography class at CMU (Fall 2018)
8 Bill Freeman, Antonio Torralba, and Phillip Isola's 6.819/6.869- Advances in Computer Vision class at MIT (Fall 2018)
9 Alyosha Efros'- Image Manipulation and Computational Photography class at Berkeley (Fall 2018)
10 Alyosha Efros, Jitendra Malik, and Stella Yu's CS280- Computer Vision class at Berkeley (Spring 2018)
11 Deva Ramanan's - Computer Vision class at CMU (Spring 2017)
12 Trevor Darrell's - Computer Vision class at Berkeley
13 Antonio Torralba's - Advances in Computer Vision class at MIT
14 Michael Black's - Introduction to Computer Vision class at Brown
15 Kristen Grauman's - Computer Vision class at UT Austin
16 Alyosha Efros' - Computational Photography and Learning-Based Methods in Vision classes at Carnegie Mellon 9092372797
17 https://www.javatpoint.com/computer-graphics-elastic-or-rubber-band-techniques
18 http://www.cs.jhu.edu/~misha/ReadingSeminar/Papers/Ma00.pdf
19 https://www.geeksforgeeks.org/image-classifier-using-cnn/
20 http://vqlsr.com/vision-services/computer-vision.html

20EC3075 – Human Machine Interface & Brain Machine Interface

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of HMI: Asimov’s Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics.	**1,2**	**1**
CO2	Understanding the HMI Technologies such as GMOS Models, CMN-GOMS, Fitts Laws, Hick-Hyman Laws, Norman’s 7 Principles.	**1,2/1**	**2**
CO3	Understanding the concept of Brainwaves & BMI	**1,2/1**	**2**
CO4	Analysing Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FEM]	**1,2**	**2**

Syllabus:

(a) Intro. to HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics

Introduction to the course and to HMI/HCI, HMI/HCI Its history Relation to Ergonomics and Human Factors Problems and challenges Recurrent HMI Themes, Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques.

Design rules Authority vs. generality Principles, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS, Fitts' law and Hick-Hyman's law, Guidelines in HCI: Norman's seven principles, Norman's model of interaction, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough.

(c) Brainwaves & BMI: Alpha, Beta, Theta, Gamma wave, Brain-Control Interface, ARMA Model

Introduction to ***Brain Control Interface*** Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI Brain signal acquisition, Experiment design and data analysis (with explanation of one-way ANOVA), ARMA Model

(d) Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FSM] Task modelling and analysis through Hierarchical task analysis (HTA), GUI design for a mobile phone based Matrimonial application, Employment Information System for unorganized construction workers on a Mobile Phone. Dialog Design using FSM (finite state machines), Cognitive architecture, Object Oriented Modelling of User Interface Design.

Text Books:

1. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.

Reference Books:

1. B. Schneiderman; Designing the User Interface, Indian Reprint, Addison Wesley 2000.
2 Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012

Web References

1 https://www.expertsnotes.com/2016/04/jntuk-r-10-4-2-cse-human-computer.html
2 https://nptel.ac.in/courses/106103115/4
3 http://www.eolss.net/sample-chapters/c18/e6-43-37-06.pdf
4 https://www.Tutorials.in/How_Does_Your_HMI_Design.
5 Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006

20EC3076 – Designing Automation Systems & Assistive Robotic Systems

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Acquire knowledge about the fundamental principles, hierarchy level, architecture, functions and implementation strategies of Distribution Automation Systems (DAS) and Distribution Management Systems (DMS).	1,2	2
CO2	Provide solutions for Automation in Home, industry, Advanced Research Laboratories	1,2/1	3
CO3	Understanding industrial robots and robotics arms, cooperative robotics arms, automated kitchen, studying about various home automation.	1,2/1	3
CO4	Study of the robot assistive technology; understanding the Human Activity Assistive Technology (HAAT) model. Understanding of the Assistive Robotic Manipulators (ARM) Justify the use of robots in rehabilitation. Discuss the current international safety standards for robotic assistive technologies.	1,2	2

Syllabus:

Introduction to Automation Systems-Definition, types, merits and Criticism- Architecture of Industrial Automation Systems-Manufacturing plants and operations-Automation Strategies-Basic elements of Automated system- Advanced Automation Functions-Levels of Automation. Industrial control Systems- Process, Discrete manufacturing industries- Continuous and Discrete Control systems-An overview of Computer process control- Fundamentals of automated assembly system. Actuators& Sensors, Fluid Power and Electrical Actuators Piezoelectric Actuator; Sensors for position, motion, force, Strain and temperature

Home Automation: Introduction Home Automation; Determining Home Automation Needs (and Wants); Automating Inside Your Home: Keeping Your Cool or Turning Up the Heat, Automated Lighting, Safe, Sound, and Hunkered Down, Home, Home on the Automatic Range: The Automated Kitchen, Monitoring Water Use and Detecting Leaks, Smart Home Entertainment, Automating Outside Your Home: Checking the Weather, Ten Easy Ways to Begin Automating in Home: Philips Hue products.

Industrial Robots and Robotic Arms: Study of Basic Functionality of industrial Robots (RIPA) versions, Operations of Cooperative Robotic Arms; Robotics Arms in Advanced Automation; Industry Robots in conveyor Belts operations, robots in industry real time embedded systems, Robotic Arm Coordinates and Home Position; Robotic Elbow; An Intuitive Teleoperation of Industrial Robots: Approach Manipulators by Using Visual; Tracking Over a Distributed System; Baggage Collection Automation Applications for Human Safety: Dangerous domains for humans, (Mine Detection), Hazardous domains for humans (chemical fumes etc.), Nuclear Biological Chemical warfare, dangerous exploratory missions UAVs, unmanned Rockets, Mars Mission, Chandrayaan.

Assistive Robotic System (ARS): Fundamentals of Robotic Assistive Technologies; Assistive Robotic Manipulators (ARM): Principles of Assistive Robotic Manipulators, Working Definition of Assistive Robotic Arms, functionality of the Assistive Robotic Arms, feature and limitation ARM; Rehabilitation robotics; Surgical robotics; Assistive Robots in Healthcare/Medical: Medical Device Packaging, Lab automation, Neurosurgery, Cutting Bone!, Therapeutic massage; Case studies on Assistive Robotics Systems in Healthcare /Medical Firm forms: Telepresence, Surgical Assistants, Rehabilitation Robots, Medical Transportation Robots, Sanitation and Disinfection Robots, Robotic Prescription Dispensing Systems; collaborative study on Socially Assistive Robotics for Personalized Education for Children; Best Robot Assistants Comparison :Anki Cozmo, Mibro, littleBits Star Wars Droid Inventor Kit, iPATROL RILEY, Beam System Remote Technology, ector Robot by Anki, Sphero BOLT App.

Text Books

1 Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.

2 N.Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Syetms, Printice Hall India Pvt. Ltd.

3 Home Automation For Dummies; Published by: John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030-5774, www.wiley.com Copyright © 2015 by John Wiley & Sons, Inc., Hoboken, New Jersey

4 and J. Pratt. Mercury Learning and Information, 2016. ISBN: 978-1-942270-04-1.)

5 Robotics, Automation, and Control in Industrial and Service Settings Zongwei Luo South University of Science and Technology of China

6 Robotic Assistive Technologies Principles and Practice, Edited by Pedro Encarnação and Albert M. Cook Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

Reference Books

1 Mikell P Groover,Automation, Production Systems, and computer integrated Manufacturing‖, Prentice Hall, 2001.

2 Deb S R.and DebS., ―Robotics Technology and Flexible Automation‖, Tata McGraw Hill Education Pvt. Ltd, 2010.

3 Manual Prepared by the Department of Robotics and Automation Engineering, 2015.

4 Robotic Prosthetic Limbs Ruwan Gopura,1 Kazuo Kiguchi,2 George Mann,3 and Diego Torricelli

Signal Processing

20EC3081 – Speech Signal Processing

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of speech signal processing	**1,3/1**	**1**
CO2	Understand and applications of various transformation techniques for filter.	**1,3/2**	**1**
CO3	Understand the concepts and methods of aliasing, auto correct and filtering.	**1,3**	**1**
CO4	Analysis and understand advance topics in speech signal processing.	**5**	**4**

Syllabus:

SPEECH FUNDAMENTALS: Production and Classification of Speech Sounds; Acoustic Phonetics – Vowels, diphthongs, fricatives etc., Speech parameters-Speech production, Labelling.

TRANSFORMATIONS FOR SPEECH SIGNAL PROCESSING: Fourier Transformation, Design of Filters- Wide band and Narrow Band- Hilbert transform- Auto correlation and Hilbert huang transforms for pitch estimation- STFT- STFT representation of speech - Z transform and Pole Zero concepts, LTI, Modelling of speech: Inverse filtering, Pole zero, Z transform.

ANALYSIS AND SYNTHESIS OF SPEECH:

Speech Analysis: Time domain: Analysis and Synthesis of Pole-Zero Speech Models; Aliasing, Spectral: Short Time Fourier analysis - filter bank design - speech coding – subband coding of speech - transform coding - channel vocoder - vector quantizer coder. introduction to LPC.

Speech synthesis - Pitch extraction algorithms, MFCC- autocorrelation pitch trackers - voice/unvoiced detection - homo morphic speech processing - homomorphic systems for convolution - complex cepstrum - pitch extraction using homomorphic speech processing. Introduction to vowel synthesis.

ADVANCED TOPICS and APPLICATIONS OF ANN, AI and ML.

Introduction to Hidden Markov Modelling- Application of HMM: making a digit recognition system -Automatic segmentation and labelling of speech based on HMM- speaker verification systems – speaker identification Systems - ANN,CNN, ANN and CNN for Automatic speech and speaker recognition- Introduction to Text to speech and Speech to text, Introduction of AI and ML based applications in speech domain.

Text Books

1. Biing-Hwang Juang, Lawrence Rabiner, B. Yegnanarayana, "Fundamentals of Speech Recognition" Pearson Education, 1st Edition 2008.

2. Lawrence Rabiner, Ronald Schafer,"Theory and Applications of Digital Speech Processing," Pearson Education, 2011.
3. Thomas parsons, “voice and speech processing”, Mcgraw hill series . 1987.
4. T.F.Quatieri, "Discrete time speech signal processing, Prentice Hall,2007.

References Books

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons.
3. Papamichalis P.E., “Practical Approaches to Speech Coding”, Texas Instruments, Prentice Hall,2003.
4. Douglas O’Shaughnessy, “Speech Communications: Human & Machine”, 2nd Ed., Wiley India, 2000
5. Dong Yu, Lie deng "Automatic speech recognition a deep learning approach, Springer 2014.

Web references

1. https://www.youtube.com/watch?v=X_JvfZiGEek
2. https://www.youtube.com/watch?v=3MjIkWxXigM
3. https://nptel.ac.in/courses/117/105/117105145/
4. https://www.youtube.com/watch?v=RBgfLvAOrss
5. https://www.youtube.com/watch?v=Xjzm7S__kBU
6. https://www.youtube.com/watch?v=gMQyGASOZO0

20EC3082 – Digital Image Processing

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Selected, as high level mathematics are used to model 2D complex systems; The principles of mathematics help solve Image Processing problems effectively.	**1,3**	**2**
CO2	Selected, to simulate algorithms for Systems using 2D methods	**1,3/1,2**	**3**
CO3	Selected, to create a problem identifier and learner, to find solutions in complex search space.	**1,3**	**3**
CO4	Selected, with simulations that can apply 2D models to solve Image processing problems.	**5**	**3**

Syllabus:

Introduction to DIP: What is digital image processing? Applications, Fundamental steps of DIP, Components of DIP systems, Visual Perception and electromagnetic spectrum, Image Sensing and Acquisition including A Simple Image Formation Model using illumination and reflectance, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Image Operations on a Pixel Basis, Linear and Nonlinear Operations, Image transforms: 2D orthogonal and unitary transforms. Separable unitary transforms. DFT, WHT, KLT, DCT, Image Enhancement in both Spatial and Frequency domains, Basic Gray level transformation,

Image enhancement: Histogram processing Enhancement using Arithmetic and logic operations, Spatial filtering: Smoothing and Sharpening filters, Enhancement using Frequency domain:2D DFT and inverse DFT, Basics of filtering in the frequency domain, Basic filters and their properties, Frequency domain smoothing, sharpening filters, Homomorphic filtering.

Image Degradation / Restoration :process Noise Models: Gaussian, Rayleigh, Gamma, Exponential Uniform, Impulse, Salt and Pepper noise. Noise reduction: Spatial filtering approach: Mean, Order statistics filters Noise reduction: Frequency domain filtering approach: Band rejection, Band pass and Notch filters, Introduction to Segmentation: Detection of discontinuities: Point detection, Line detection, Edge detection. Gradient, Laplacian Edge linking and Boundary detection: Local processing, Thresholding for segmentation

Image Compression and colour image processing : Introduction to compression: Coding redundancy, inter pixel redundancy and Psych-visual redundancy, Image compression model. Error free compression: Huffman coding, Arithmetic coding and Bit plane coding Lossy Compression: Transform coding Colour fundamentals, colour models: RGB, CMY/CMYK, HIS, Pseudo colour image processing, Full Colour Image processing: Smoothing and Sharpening Spatial Filtering,LZW coding,JPEG

Text Books

1 Digital Image Processing (3rd Edition) Hardcover – August 31, 2007 by Rafael C. Gonzalez, Richard E. Woods.

2 Algorithms for Image Processing and Computer Vision Paperback – December 21, 2010 by J. R. Parker.

3 García, Gloria Bueno, Oscar Deniz Suarez, José Luis Espinosa Aranda, Jesus SalidoTercero, Ismael Serrano Gracia, and Noelia VállezEnano. Learning image processing with opencv. Packt Publishing Ltd, 2015.

Web References

1 https://nptel.ac.in/courses/117105079/

2 https://nptel.ac.in/courses/106105032/

3 https://nptel.ac.in/courses/117104069/

20EC3083 – BIOMEDICAL IMAGE ANALYSIS

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Fundamentals of Digital image	**1,3**	**2**
CO2	Image Enhancement in Spatial and Frequency domain	**1,3/1**	**2**
CO3	Image Segmentation and Compression	**1,3/2**	**2**
CO4	Morphological Image Processing and Advanced Topics	**5**	**2**

Syllabus:

Fundamentals of Digital image: Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two-dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2Dconvolution, Color models.

Image Enhancement in Spatial and Frequency domain: Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

Image Segmentation and Compression: Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering. Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

Morphological Image Processing and Advanced Topics: Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Diffusion Tensor Imaging.

Text Books

1 Digital Image Processing, Gonzalez and Woods- Pearson Education
2 Digital Image Processing, S. Sridhar – Oxford University Press.
3 Fundamentals of Digital Image Processing, A.K. Jain .P.H.I.
4 Digital Image Processing, William Pratt- John Wiley.

Web References

1 https://www.coursera.org/lecture/image-processing/1-introduction-to-medical-imaging-duration-07-03-QhMgY

2 https://www.csie.ntu.edu.tw/~rfchang/lab/pdf/AIT/02MIP.pdf
3 https://www.youtube.com/watch?v=3qJej6wgezA
4 https://www.youtube.com/watch?v=IcBzsP-fvPo
5 https://www.youtube.com/watch?v=twsV81UFFcE
6 https://www.youtube.com/watch?v=gmi4ah7YAi0

20EC3084 – Statistical Signal Processing

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Generalize the properties of statistical models in the analysis of signals using Stochastic processes	**1,2**	**1,2**
CO2	Differentiate the prominence of various spectral estimation techniques for Achieving higher resolution in the estimation of power spectral density	**1,2/1**	**3**
CO3	Design and development of optimum filters using classical and adaptive algorithms	**1,2/2**	**3**
CO4	Design based on Kalman filtering and extended Kalman filtering	**2,4**	**1**

Syllabus:

Review of statistical concepts and signal modeling: Random variables, Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables, Central Limit theorem, Random processes, ergodicity, wide-sense stationary processes, autocorrelation and auto covariance functions, Gaussian Process and White noise process, Autoregressive Moving Average (ARMA) Processes. Signal Modeling: Least Square method, Pade Approximation, Pole-zero and all-pole modeling, the Autocorrelation and covariance method, ARMA models

Optimum Filtering: Linear mean square filtering, Wiener-Hoff Equation, FIR wiener filter, linear prediction and noise cancellation, causal IIR Wiener filter, causal linear prediction, Wiener deconvolution

Spectrum Estimation: Nonparametric methods: Periodogram method and its performance, Bartlett's and Welch's method, Performance comparision. Minimum variance spectrum estimation, maximum entropy method, Parametric methods: ARMA spectrum estimation, Frequency estimation

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking

Text Books

1 M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 2014

2 S. M. Kay, Fundamental of Statistical Signal Processing: Estimation Thoery Vol-I PHI-2010

3 M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

4 "Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

5 Jerry M. Mendel, Lessons inEstimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995

6 Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1985.

7 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

8 Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

Web References

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

2 https://onlinecourses.nptel.ac.in/noc18_ee33/previe

3 https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

4 https://www.youtube.com/watch?v=qqeRUgAvmzQ

5 https://www.youtube.com/watch?v=o1-hj6GKaFY

6 https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3085 – Adaptive Signal Processing

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Comprehend design criteria and modelling adaptive systems and theoretical Performance evaluation	**1,2**	**1,2**
CO2	Design a linear adaptive processor and Kalman filters	**1,2/1**	**3**
CO3	Apply mathematical models for error performance and stability	**1,2**	**3**
CO4	Comprehend the estimation theory for linear systems and modelling algorithms.	**2,4/2**	**1**

Syllabus:

Winer Filters: FIR Wiener filters, linear prediction-forward and backward predictions, Levinson-Durbin Algorithm and lattice filter, IIR Wiener filters, non-causal Wiener filter, innovation and causal Wiener filter.
Kalman filters: Gauss-Markov state variable models; innovation and Kalman recursion, steady-state behavior of Kalman filters.

Adaptive filters: steepest descent solution of FIR Wiener filter, LMS algorithm-convergence, steady-state behavior and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation, models.
Advanced Adaptive algorithms: Normalized algorithms, Variable Step Size algorithms, Block based adaptive algorithms, Time domain and frequency domain, convergence analysis.

Text Books

1 S. Haykin, Adaptive Filter Theory, Pearson, 5ed, 2014

2 D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, McGraw Hill, 2000

3 Paula S. R. Diniz, "Adaptive Filtering, Algorithms and Practical Implementation", Third edition, Springer Publishers, 2008.

4 Ali H Syed, John Wiley and Sons, "Adaptive Filters", New Jersey, USA, 2008.

5 Farhang-Boroujeny, B., John Wiley and Sons, "Adaptive Filters-Theory and Applications", Chichester, UK, 1998.

Web References

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

2 https://onlinecourses.nptel.ac.in/noc18_ee33/previe

3 https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

4 https://www.youtube.com/watch?v=qqeRUgAvmzQ

5 https://www.youtube.com/watch?v=o1-hj6GKaFY

6 https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3086 – Detection and Estimation of Signals

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Recognizing the fundamentals of Probability and Random Processes	1,2/1	1,2
CO2	Understanding the statistical decision theory and signal detection processes.	1,2	2
CO3	Explore the estimation theory and their properties	2,4/2	3
CO4	Analyzing the state estimation techniques	2,4	2

Syllabus:

Review of Probability and Random Processes: Probability, conditional Probability and Bayes' rule, random variables, random data, Generation of Pseudo-random noise, Moments and moment generating functions, distributions, random processes, power spectral density, ergodicity.

Statistical Decision Theory and signal detection: Bayes' criteria, binary and M-ary hypothesis testing, Maximum likelihood , Neyman-Pearson criterion, composite hypothesis testing, sequential detection, energy detector, detection in presence of noise.

Estimation Theory and properties of estimator: Introduction, Generalized likelihood ratio test, MAP and ML estimation, Uniform cost function, Mean Square estimation, Criteria for good estimator, CR inequality, Bayes' estimation, Multiple parameter estimation.

State Estimation: State-space model and the optimal state estimation problem, Prediction, Digital Discrete Kalman Filter, Weiner filter, Stored Data Weiner Filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking.

Text Books

1 Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House Inc, Norwood, MA 02062, 2005.

2 Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall New Jersey, 1993.

3 Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.

Reference Text Books

1 Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

2 Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.

3 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing, with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

4 Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

20EC3087 – Biomedical Signal Analysis

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Basics	**1,2/1**	**1,2**
CO2	Modalities, Signal Processing Methods	**1,2/1**	**3**
CO3	Modern Biomedical Technologies & Instruments	**1,2**	**3**
CO4	Advanced Applications	**2,3**	**1,2**

Syllabus:

Basics: Sources of bio-potential, cell structure, activity, resting potential, action potential, propagation of action potentials in nerves; rhythmic excitation of heart, heart activity complexity.

Modalities, Signal Processing Methods: ECG: Pre-processing, wave form recognition, EEG: Evoked responses, averaging techniques, pattern recognition, epilepsy detection. EMG: Wave pattern studies, biofeedback and other potentials. MRI, NMR, Ultra -------------- Sound, CT-Scan, 3D Imaging Techniques.

Modern Biomedical Technologies & Instruments: Robotic Hand-evaluation, functional block diagram, operation; Tissue Diagnostics using Lasers - Diagnostic Applications of Lasers in Ophthalmology and Flow Cytometry; Remote Surgery- methodology, components; Remote Health Care monitoring systems; Health Informatic Systems.

Advanced Applications: Wavelet decomposition of physiological signals for analysis; Wavelets' approach to Heart Rate, Speech, Corona, Brain, Prosthetic; Artifacts in bio-potentials, artifact elimination methods and structures, beamforming in brain analysis.

Text Books

1 Rangaraj M Rangayyan, John Wiley and Sons, "*Biomedical Signal Analysis- A case study approach*", USA, 2ed, 2016.
2 E.N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley and Sons, 2001.
3 Cromwell, Biomedical Instrumentation and Measurements, Pearson, 2015.
4 Ronald W. Waynant, Lasers in Medicine, CRC Press, 2001
5 Edward H Shotliffe, *Biomedical informatics*, Springer, Fourth edition, 2013.

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2 https://www.sciencedirect.com/topics/engineering/biopotential
3 https://www.ibiology.org/techniques/introduction-to-flow-cytometry/
4 https://www.youtube.com/watch?v=ElZU13meAK4
5 https://www.uni-

muenster.de/AMM/num/Vorlesungen/Skiseminar_WS07/talks/Stefanie_Sillekens.pdf

RF & Microwave

20EC3091 – Microwave Engineering

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the various microwave devices.	**1,2/1**	**1**
CO2	Analysis of scattering parameters of Tee junction and passive components	**1,2/2**	**1**
CO3	Understand the concept of design of different microwave filters	**1,2**	**1**
CO4	Analyse the applications and advanced topics of microwave	**2,3**	**2**

Syllabus:

Microwave devices*:* Introduction to microwave Components, Klystron, TWT, Magnetron. Solid state devices: IMPATT, TRAPATT, BARRIT, GUNN and PIN.

Microwave Passive Components and Waveguide Tees: Significance of scattering parameters and formation of S-matrix for n port network. Scattering parameter analysis of E-Plane, H-Plane and Magic Tee. Directional coupler, Isolator, gyrator, circulator. Microwave bends, twists, corners and posts.

Microwave Filters and Periodic structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Microwave Applications: Microwave medical applications, X-ray, Microwave Imaging, and MRI Scanning. Communication Radar applications, Satellite RF Link Applications

Text Books	
1	Microwave devices and circuits- Samuel Y.Liao, Pearson, 3rd edition, 2003.
2	Microwave engineering passive Circuits, Peter A.Rizzi, PHI, 1999.
3	Robert E Collin, "Foundation for Microwave Engineering", McGraw-Hill
Reference Books	
1	Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", McGraw-Hill.
2	"Analysis Methods for RF, Microwave, and Millimetre-Wave Planar Transmission Line Structures", by Cam Nguyun

20EC3092 – Antenna Design & Wave Propagation

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to identify the radiation fields and antenna fundamentals	**1,2**	**BTL**
CO2	Able to Identify different types of antennas and arrays	**1,2/1,2**	**1**
CO3	Understand the concept of antenna measurements, design and testing.	**1,2**	**1**
CO4	Study of real-world applications of various antennas.	**5**	**1**

Syllabus:

Radiation concept and antenna fundamentals: Concept of Vector Potential, Radiation of Small Current Element, Radiation of Short Dipole, Radiation from Half-Wave Dipole and its Radiation Resistance & Quarter-Wave Monopole, Antenna Parameters like Radiation Patterns, Directivity, Gain, Radiation Resistance, Polarization, Effective Length and Effective Area and Antenna efficiency
Antenna types and Arrays: Log periodic antenna, Reflector antenna, Lens Antenna, Horn antenna. Two Element Arrays, N- Element Linear Arrays – BSA, EFA, Directivity N-Element Linear Array with Uniform Spacing, Non-Uniform Amplitudes, Binomial Arrays, Principle of Pattern Multiplication.

Antenna Measurement and testing: Introduction, Impedance/VSWR measurements, scattering parameters Types of Ranges: Anechoic Chamber, Elevated Ranges, Slant Range Ground Ranges, Near Field Ranges, CATR, Radiation Pattern Measurements, Gain Measurements
Real world applications of Antennas: Antenna design for mobile applications Antenna design for vehicular applications, Antenna design for satellite applications

Text Books

1 C.A Balanis, "Antenna Theory", John Wiley & Sons, 2nd ed.
2 E.C. Jordan and K.G. Balamain, "Electromagnetic Waves and Radiating Systems". 2nd ed., Pearson
3 John D Kraus, "Antennas". 2nd ed., Mc Graw-Hill
4 S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.

Reference Books

1 3. Evans, Gray E," Antenna Measurements Techniques", Artech House, Inc
2 4. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements, Scientific Atlants, Inc

20EC3093 – Radar Engineering & Navigational Aids

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the essential principles of operation and design of simple radar systems and analysis of essential elements of	**1**	**2**

	Transmitters , Receivers and design of simple Radar Receiver		
CO2	Understand various types of Radars	**1,2/1**	**2**
CO3	Understand the principles of various Radars systems used in different applications	**3/2**	**2**
CO4	Understand the basic concepts related to different systems and sensors for navigation.	**3**	**2**

Syllabus:

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. **Transmitter and Receivers**: RF Power Sources. The Radar Receivers, Receiver Noise Figure, Duplexers and Receiver Protectors, Radar Displays.

Radar types: MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters. **Tracking:** Sequential Lobing Radar, Conical Scan and Monopulse acquisition and tracking, Radars for Air Traffic Control applications.

Radar Applications:, SAR, LIDAR, OTH radar, Remote sensing radar, Airport surveillance radar, Weather / Meteorological radar, Ground penetration radar, Through-wall radar, Automobile radar.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation **Radio Ranges:** LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Text Books

1 Merrill I Skolnik, “Introduction to Radar Systems”, 3rd Edition, TMH, (2003)
2 William L. Melvin, James A. Scheer, “Principles of Modern Radar”, SciTech Publishing.
3 Elements of Electronic Navigation Systems", Tata McGraw-Hill,

Reference Books

1 Peyton Z Peebles Jr, “Radar Principles”, John Wiley Inc., (2004).
2 Donald R Wehner, “High Resolution Radar”, Artchtech house.
3 Radar Systems and Radio Aids to Navigation, Sen & Bhattacharya, Khanna publishers
4 J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004.

20EC3094 – Modern Antennas, Millimeter Waves & Applications

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and analysis of modern antenna design	**1**	**2**
CO2	Understand the concepts of mm waves and meteorological applications.	**1,2/1**	**2**
CO3	Understand and analysis of mm wave circuits.	**3/2**	**2**
CO4	Study of applications of modern antennas and mm wave radar.	**3**	**2**

Syllabus:

Modern Antennas: Phased array antennas, active phased array antennas, Biomedical antennas, Wearable antennas, Implantable antennas.
Millimeter wave Introduction: EM Spectrum, RF Range, Meteorological applications of MillimeterWaves.
Millimeter wave circuits*:* Microstrip lines, Wave Propagation in microstrip lines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits
Applications of modern antenna, Millimeter wave Radar: Inter-vehicle Communication, Space Communication, Weather Applications, and Meteorological Applications.

Text Books

1 Robert E Collin, "Foundation for Microwave Engineering", Mc Graw-Hill

2 John D Kraus, "Antennas". 2nd ed., Mc Graw-Hill

3 C.A Balanis, "Antenna Theory", John Wiley & Sons, 2nd ed.

Reference Books

1 Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures", by Cam Nguyun.

20EC3095 – Electronic Warfare, EMI & EMC

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : 19EC2112 Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concept of Electronic Warfare	**1**	**2**
CO2	Able to identify the different Jamming techniques and its methodologies	**2,3/1**	**2**
CO3	Understand the concept of design of EMC and components	**2,3/2**	**2**
CO4	Analyse, design and testing of EMI and EMC	**2,3**	**2**

Syllabus:

Basics of Electronic Warfare: Targets of Electronic Warfare Operations, A General Description of Targets of Electronic Warfare Operations, Electronic Signature, ECM, ECCM, ESM

Methods, Stealth & Applications: Mathematical Models of Signals, Systems and Techniques for Electronic jamming, Active Jamming of Radar, Passive Jamming, False Radar Targets and Decoys, Homing, Stealth Technology.

EMI & EMI Control Techniques:

EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters, EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards.

EMI Control Techniques*:* Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal control, Component Selection and mounting

EMC Design Guidelines, EMI Measurement :EMC Design Guidelines Typical Sub systems in Electronic Equipment, Transmitters, Receivers

Antenna Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers. Capacitors, Inductors, Transformers, Resistors, Conductors, Ferrite Beads, Coaxial Connectors, Conductive Gaskets.

EMI Measurements: Radiated Emission Test (OATS, Anechoic chamber) , Immunity Test, ESD, Buist, Surge

Text Books

1 V P Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press,

2 Bernard Kieser, “Principles of Electromagnetic Compatibility”, Artech House 3rd Edition.

3 Henry W. Ott, “Electromagnetic Compatibility Engineering”, A John Wiley & Sons publication.

4 Sergei A. Vakin, Lev N. Shustov, “Fundamentals of electronic warfare”, Artech

Reference Books

1 Clayton R Paul, “Electromagnetic Compatibility”, John Wiley.

2 Tim Williams, “EMC for Product Designer”, Elsevier.

3 PR Chatterton, “Electromagnetic Theory to practical design”, Wiley.

4 Sonia Ben Dhia, “Electromagnetic Compatibility as Integrated Circuits”, Springer.

5 Filippo Neri, “Introduction to Electronic Defense Systems”, Second Edition, Artech.

6 David L. Adamy, “Introduction to Electronic Warfare Modeling and Simulation”, Artech. 7. Richard A. Poisel, “Electronic Warfare Target Location Methods”, Second Edition, Artech.

Data Communication

20EC4051 – Information Theory & Coding

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction: Information theory, measure, entropy, mark-off, statistical model, Shannon's Theorem	1,2, 3,4,5/1	2
CO2	Encoding: Shannon Algorithms, Channels, Source/Huffman coding, Error Detection & Correction	1,2, 3,4,5/2	3
CO3	Types, Linear/Block codes, Matrix, Array, Table Look-up, Cyclic Code, BCH, RS, Olay	1,2, 3,4,5	3
CO4	Miscellaneous: Error Types, Bust/Random Error corr. Codes, Convolution Codes, Impulse Response, Trellis, time-domain/Transform approach, Tree representation., State representation, State-diagrams	1,2, 3,4,5	2

Syllabus:

Introduction: Information theory, measure, entropy, mark-off, statistical model, Shannon's Theorem: Introduction to Random Variables, Stationary Process, Mean, Correlation and Covariance Functions, Ergodic Process, Transmission of Random variable through LTI System, Power Spectral Density, Gaussian Process, Noise, Narrowband noise and its Representation, Fundamental limits in Information theory: Uncertainty, Information and Entropy, Source coding theorem, Data compression, Mutual information, Channel Coding theorem, Differential entropy and Mutual Information for Continuous ensembles, Information Capacity theorem and its implications, Information capacity theorem of colored noise, Rate distribution theory. Measure of Information, Mark-off Statistical Model for Information Sources, and Shannon-theorem.

Encoding: Shannon Algorithms, Channels, Source/Huffman coding, Error Detection & Correction: Shannon's Noiseless Coding Theorem, Fano Coding, Huffman Coding, Arithmetic coding, Basics of Error detection & Corrections, Channels: Symmetric Lossless, Deterministic, Useless, Binary Symmetric (BSE), Binary Erase (BEC), Cascade and non-symmetric channels.

Error Detection and Correction Types, Linear/Block codes, Matrix, Array, Table Look-up, Cyclic Code, BCH, RS, Olay: Introduction, Linear Block Codes, Binary cyclic Codes, Burst Error Correcting Codes, Convolution Codes, Performance of Block Codes-Error Correction and Error Detection, Hamming Code.

Miscellaneous: Error Types, Bust/Random Error corr. Codes, Convolution Codes, Impulse Response, Trellis, time-domain/Transform approach, Tree representation., State representation, State-diagrams: Error Correcting Codes, Cycle Codes, Burst Correction Codes, Convolution Codes, Trellis, time-domain/Transform approach, Tree representation., State representation, State-diagrams: (10Hrs)

Text Books

1 Communication Systems, Simon Haykin, Fourth Edition

2 Digital And Analog Communications, K.Sam Shanmugam,

Reference Text Books

1 Elements of Information theory, Thomas M.Cover, Joy A.Thomas, Second edition

2 Entropy and Information theory, Robert M. Gray, First Edition.

Web References

1 Fundamentals of Information Theory, Roberto Togneri, Christopher J.S.deSilva

20EC4052 – 4G Wireless Technologies and Cellular Communication

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Spreading Sequences and Multi user systems	1,2,3,4,5	2
CO2	Multi carrier Communication Systems	1,2,3,4,5/ 1,2	3
CO3	MIMO systems – spatial multiplexing. Ultra Wideband Communications	1,2,3,4,5	3
CO4	Advanced cellular communications and Miscellaneous topics	1,2,3,4,5	2

Syllabus:

Spreading Sequences and Multi user systems: Properties of spreading sequences, PN sequences, Gold Sequences and Walsh Sequences. Orthogonal variable spreading factor sequences (OVSF). Introduction to CDMA, DSCDMA, Multiuser detection, DSSS Techniques, FHSS verses DSSS

Multi carrier Communication Systems: Introduction to multiuser modulations, Principal of OFDM(Block Diagram), Cyclic Prefix, Introduction to long term evaluation(LTE-5E), Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO), Synchronization, PAPR reduction techniques, Multicarrier and Multi-access Systems- OFDMA, MCCDMA.

MIMO systems – spatial multiplexing. Ultra Wideband Communications: Channel Models, VBAST Architecture, Channel Modeling, SIMO, MISO, MIMO fading channels- MIMO diversity-Almouty, Orthogonal space time block code, OSTBC- MIMO-SSC, MIMO-OFDM, Introduction to features of UWB technology- applications, UWB indoor channel, UWB Capacity, Pulsed UWB, Pulse shape, Modulation and Multiple access of Pulse UWB, Time Hopping, DSUWB.

Advanced cellular communications and Miscellaneous topics: Study of 60 Hz cellular systems, Cellular fixed stations, Cellular systems in rural service areas, Diversity media systems with millimeter wave and Optical wave link and Cellular radio telecommunications systems, Cell Handoff, Cellular switching-Analog and Digital, Call routing-Special features of handling traffic. Challenges for Pulsed UWB systems- Multiband UWB- Modulation of Pulsed Multiband UWB, Multiband OFDM UWB, Introduction to 5G.

Text Books

1 Wireless Communication Systems, KE-Lin DU and M.N.Swamy

2 Fundamentals of Wireless communication, David TSE and Promod Viswanadhan

Reference Text Books

1 Mobile cellular Telecommunications, William C.Y.Lee, TMH Publications 2006

Web References

1 Advanced Wireless communications 4G Technologies, SAVO Glisic,

20EC4053 – Satellite Communications

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basic concepts of satellite communication	**1,2**	**1**
CO2	Design general satellite orbital terms and elements	**1,2/1**	**2**
CO3	Understand satellite subsystems which compromise space, earth segments and design uplink and downlink budgets in satellite communication	**1,2/2**	**2**
CO4	Understand the basic concepts of multiple access techniques, satellite navigation and GPS.	**1,2**	**2**

Syllabus:

Introduction: Basic Concepts of Satellite Communications: Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas.

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design Of Satellite Links For Specified C/N, System Design Examples-DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication.

Multiple Access Techniques: Frequency Division Multiple Access (FDMA), Inter-modulation, Calculation of C/N, Time Division Multiple Access (TDMA), Frame Structure, Satellite Switched TDMA, Onboard Processing, Code Division Multiple Access (CDMA), Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag.

Satellite Navigation & Global Positioning System: Satellite Navigation & Global Positioning System: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Message, GPS Signal

Levels, GPS Receiver Operation. TCP over satellite, ITU regulations, Standards and examples, DBS and DBB.

Text Books:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt – Wiley Publications– Second Edition, 2003.

2. Satellite Communications – L.Pritchard, Robert A Nelson and Henri G.Suyderhoud – Pearson Publications – Second Edition.

References

1. Satellite Communications – M. Richharia, BS Publications, Second Edition.
2. Fundamentals of Satellite Communications – K.N. Raja Rao, PHI, 2004.

20EC4054 – Optical Communication & Network

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts of optical communication	**1,2**	**1**
CO2	Analyze different optical sources, materials and structures	**1,2/1**	**2**
CO3	Evaluate different optical network protocols	**1,2/2**	**3**
CO4	Understand different optical networks	**1,2**	**2**

Syllabus:

Overview of Optical Communication: Applications, Optical Fiber Waveguide, Types, Modes: : Optical Fiber Communication system, optical fiber waveguides, types of fibers, cutoff wave length, **:** Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion.

Optical Sources & Sensors: LED, ILD, Laser Diodes, Power-Bandwidth, Materials, Structures: Introduction, LED’s, LASER diodes, Photo detectors, Photo detector noise, Photo diodes , Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers, Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links.

Optical Networks and Protocols: Node, Switching Element, WDM NW, PSTN,

Transport Layer: . Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single mode fibers, Power penalties, WDM standards, Interferometer, multiplexer, Isolators and circulators, active optical components, variable optical attenuators, tunable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources.

Misc.: Optical Switching, Wavelength Routing, Optical NWs, EDFA, SONET, SDH, OTDR, FTDX: Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA. OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides. OTDR, FTTX networks, digital cross connects. (10Hrs)

Text Books

1 Optical Communications Essentials, Keiser G

2 Optical Communications Rules and Thumb, John Miller, Ed Friedman,

Reference Text Book

1 Mathematical Principals of Optical Fiber Communications, J.K. Shaw,

20EC4055 – Next Generation Wireless Technologies(WCDMA, GPRS, GSM, UMTS)

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	5G New Radio	**1,2**	**2**
CO2	Massive MIMO for 5G and Beyond 5G	**1,2/1**	**2**
CO3	Millimeter wave Communications	**1,2**	**2**
CO4	Vehicular Communications and other Advanced Topics	**1,2/2**	**3**

Syllabus:

5G New Radio: Historical Trends in Wireless Communications, 1G, 2G, 3G, 4G, Evolution of LTE to Beyond 4G, Introduction to 5G-NR, 5G Road map, Pillars of 5G, 5G use cases-eMMB, mMTC, URLLC, Spectrum of 5G mobile systems, Frequency bands for new radio, New Multicarrier Modulation schemes, (FBMC, GFBM, BFDM, UFMC, and TFP), Waveform Pulses – RRC pulse, PHYDYAS pulse, DC pulse.

Massive MIMO for 5G and Beyond 5G: Introduction to MIMO, Massive MIMO theory-(Downlink, Linear pre-coding schemes, Uplink, Linear detection schemes, Channel estimation), Massive MIMO channels- (Existing conventional MIMO models, Necessary model extensions, MIMO extension of the COST2100 channel model), Beyond 5G-Non orthogonal multiple access (NOMA), Machine type communications, Device to device communications.,

Millimeter wave Communications: Millimeter wave characteristics, Development of millimeter wave standards, Modulations of millimeter wave communications-(OOK, PSK, FSK), Millimeter wave link budget, Transceiver Architecture, Millimeter wave antennas-

Path Loss, Antenna directivity and Antenna beam width, Advanced diversity over MIMO channels for millimeter wave systems-(Spatial and Temporal diversity, Spatial and Frequency diversity), Preamble design.

Vehicular Communications and other Advanced Topics: Introduction to Vehicular communication, Applications of Vehicular communications- (Safety, Resource efficiency, Infotainment), Communication Regimes- (Bi-directional, position based, Multi hop position based), Architectures for intelligent vehicles- (protocol architectures in communications, architectures for platoon, architectures for sensors)

Overview of Cognitive Radio technology in 5G wireless networks, Spectrum optimization using Cognitive Radio, Dynamic spectrum access, Cognitive Radio and Carrier Aggregation, Key requirements and challenges for 5G 10Cognitive terminals.

RAN architectures for GSM/GPRS, EDGE, UMTS

Text Books

1 5G NR: The Next Generation Wireless Access Technology, Erik Dahlman, Stefan Parkvall and Johan Skold, Academic Press, 1 edition (17 August 2018).

2 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez Wiley, 1 edition (27 April 2015).

Reference text books

1 Signal Processing for 5G: Algorithms and Implementations, Fa-Long Luo and Charlie Jianzhong Zhang, Wiley-Blackwell, 1 edition (14 October 2016)

2 A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, Mohammad Asif Habibi, Meysam Nasimi, Bin Han, May 28, 2019, date of current version June 11, 2019.

3 Emerging wireless lans, wireless pans, and wireless mans, yang xiao yi pan, a john wiley & sons, inc., publication, 2009

4 Wireless communication standards, Todor cooklev, IEEE press,2004

Web References

1 Vehicular 2xcommunications, Radu Popescu Zeletin, iljaradusch, Mihai Adrial, Springer Verlog Berlin and Heidelberg Gmbh & Co.KG

20EC4061 – TCP/IP & Other Protocol Suites

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the evolution of different TCP/IP Protocol Suites, Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP and ARP	1,2/1	2
CO2	DHCP Theory of Operation, DHCP Architecture, , DHCP Auto-Configuration: Network Address Translation	3,4,5/2	3
CO3	TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM	3,4,5	3
CO4	Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12]	1,2	2

Syllabus:

Internet Address Architecture Basics:

Architecture: Brief History, Protocols and Standards, Standard Organizations, Internet Standards, Internet Administration, Architectural Evolution of TCP/IP TCP/IP Protocol Suite: Comparisons between OSI/ISO & TCP/IP Protocol Suite, Layers in the TCP/IP Protocol Suite, Addressing: Physical, Logical, Port and Application Specific Address. IP Addressing: (IPv4 and IPv6): Class full, Classless, CIDR, Special and Network Address Translation (NAT) The Address Resolution Protocol ARP: Packet Formats, Encapsulation, Operation, Proxy ARP, ARP in LAN and WANATM ARP:

ARP Package: Catch Table, Queues, Input Output Module, Multi Protocol Over ATM (MPOA)

System Configuration & Details

DHCP Theory of Operation: Introduction, Operation, Allocation of DHCP: Remote, Automatic and Manual. DHCP Architecture: DHCP Client, Server, Relay Agent, Process, Designing of DHCP: Setting up DHCP In A Small Office, DHCP

Auto-Configuration: DHCP Client, Server, Relay Agent, Process, Network Address Translation: Methods of Translation, NAT, NAT Traversal, Dynamic Network Address translation, NAT in IPv6, NAT in PIX ,Google Cloud NAT Architectural View

TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM

TCP: Principal, operational , Segment Structure of simplified TCP, TCP Connection Management: Connection Establishment, Transfer, Termination and Reset, Time out and Data flow (Error and Flow Control), Congestion control, (Congestion Control and avoidance algorithm(NEW Rano – RFC 6582))DNS: Distribution of Name Space and Defined Zones, DNS in Internet (Generic, Country and Reverse),Dynamic Domain Name System, DNS Security, TLS algorithm (Transport Layer)

Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP

Fragmentation, IP Sec, EAP]

ICMPv4/v6 : Datagram Structure of Internet Message Control Protocol V.4 (ICMPv4 & ICMP v6), Encapsulation in ICMPv4/v6, Common error messages in ICMPv4 Type 3 and ICMPv6 Type 1 Compare and contrast between ICMPv6 with ICMPv4. EAP: Multicast Listener Discovery (MLD) and IGMP Windows Sockets. Position of UDP in the TCP/IP protocol suite, User Datagram format, Basics of IP Fragmentation, Reassemble Header Format of IP Fragmentation, TCP Segmentation, Difference Between IP Fragmentation and TCP Segmentation, Extensible Authentication Protocol (EAP) standards and Mechanisms (IEEE 802.11, IEEE 802.1x)

Text Books

1 TCP/IP Protocol Suite, Behrouz A. Ferouzan, Fourth Edition

2 The DHCP Handbook, Ralph Droms, and Ted Lemon, Second Edition

Reference Test books

1 Enabling Enterprise Multi homing With Cisco IOS Network Address Translation (NAT), Praveen Akkiraju, Cisco Consulting Engineering Kevin Delgadillo, Cisco IOS Product Marketing YakovRekhter, Cisco Fellow

1 PRO DNS and Bind, Ronald G.F.Aitchison,

1 Cisco certified Network Associate (200-120)

Web References

1 http://dkim.org/

2 Data and Computer Communications, William Stallings, Tenth Edition

3 https://notes.shichao.io/tcpv1/ch8/

4 IP Datagram Reassembly Algorithms David D. Clark (July 1982),

5 https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh945104(v=ws.11)

20EC4062 – VoIP Systems & Broad Band Networks

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of Classical Telephony, IP Networking	1,2	2
CO2	Understand and analyze different VoIP Architectures and Protocols	3,4,5/**1,2**	3
CO3	Understand Broadband Wireless & Access Technologies	3,4,5	3
CO4	Understand and analyze Broadband Optical NWs and Multimedia	1,2	2

Syllabus:

Classical Telephony:

Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling, PCM, digital channel & bandwidth constraints, SS7, Services.

IP Networking Review (simple): Protocol layering, encapsulation, Ethernet, QoS at layer 2, IP, UDP, TCP,IP Addressing (network, subnet, NAT),IP Routing (RIP, OSPF).

Overview of VoIP Architectures and Protocols:

Peer protocols (SIP, H323): signaling, call routing, Master-slave protocols (MGCP/Megaco et.al.): signaling, call routing, SS7 Transport (SIP-T), RTP and Codecs, RTP and RTCP: real time traffic over IP (rfc 1789), Codecs (compression, bandwidth, quality), Waveform codecs (G711, G726), CELP codecs (G729, G723, etc.), Bandwidth control (VAD, dynamic packing, etc.).

SIP: Signaling Protocol Components (RFC 3261),SIP language elements, call flows, Network routing: Proxies, Servers, Services, Advanced Routing, Presence/Chat, SIMPLE, ENUM, DNS, Firewalls, NATand STUN. Network QoS and QoS Mechanisms (DFWQ, MPLS)

Broadband Access Technologies (BAT):

An Overview of Broadband Services and Emerging Technologies; Digital Subscriber Lines for BAT: Asymmetric Digital subscriber lines (ADSL), very high bi trate DSL (VDSL), Cable Modem for BAT: Dual Modem Operation, ATM centric VS IP; Fiber Access Technologies BAT: Architecture and Technologies Switched Digital Video (SDV), FTTH, FTTB.

Broad Band Wireless for BAT: Fixed wireless broadband WiMAX, Direct Broadcast Satellite (DBS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G, ITU spectrum management for mobile broadband, Long Term Evolution (LTE) , LTE-Advanced radio access technologies.

Broadband Passive Optical Networks: PON Architectures-PON Standards History and Deployment-Broadband PON- Ethernet PON- next-generation broadband optical Access networks, Upstream bandwidth allocation of PON, Variants of PON: APON/BPON, EPON and GPON

Broadband Optical NWs and Broadband and Multimedia:

Broadband optical Access Introduction, Evolution of optical technology, Trends in Broadband Services, Optical Broad band services, Fiber to neighborhood (FTTX) Architecture, ITU-T PON standards, PON Technology background, Multimedia Network-Connection and Communication Mechanism.

Text Books

1 Internet Communications Using SIP, Henry Sinnreich and Alan Johnston, Willey (second edition 2006).

2 IP Telephony, Oliver Hersent, Jean-Pierre Petit, and David Gurle, Wiley (2005).

3 Broadband Optical Networks and Fiber-to-the-Home, Chinlon Lin,

Reference Textbooks

1 Broadband Optical access Networks, leonid G. Kazovsky, Ningcheng, Wei-taoshaw, David Gutierrez, Shing-wawong.

2 RTP: A Transport Protocol for Real-Time Applications, Schulzrinne, H., et al., RFC
3550, 2003

3 RTP Profile for Audio and Video Conferences with Minimal Control, Schulzrinne, H.,

RFC 3550, 2003.
4 Understanding Session Internet Protocal (SIP), Alan. B. Jhonston, 2nd Edition

Web References

1 SIP: Understanding the Session Initiation Protocol, Johnston, A. (2015), Fourth Edition. (ISBN: 1608078639).
2 Wireshark 101: Essential Skills for Network Analysis (Wireshark Solutions). Chappell, L. (2013). (ISBN 1793939723)
3 Fundamentals of WiMAX: Understanding Broadband Wireless Networking, Jeffrey. G, Andrews, Arunabha Ghosh and Rias Muhamed, Pearson Education, 2007

20EC4063 – 5G Mobile, Wireless Technologies & IEEE 802 Standards

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Into. To 5G & RF Front-End: LTE Beyond 4G, Building Blocks of 5G, 5G Arch., 5G for IoT Apps:	1,2	2
CO2	5G Waveforms, Channels, Networking: 5G Radio Access Technologies:	3,4,5/1	3
CO3	5G Evaluation & Applications: MTC, D2D Communication, Multi-hop D2D, Multi-carrier D2D:	3,4,5/2	3
CO4	IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), 4G/5G	1,2	2

Syllabus:

Into. To 5G & RF Front-End: LTE Beyond 4G, Building Blocks of 5G, 5G Architecture, 5G for IoT Applications:
Introduction, Historical Trend of Wireless Communication, Evolution of LTE Technology to Beyond 4G, 5G Road map, 10 Pillars of 5G, IoT relation to 5G, From ICT to the whole economy, Rationale of 5G: High data volume, Global initiatives, Standardization activities, 5G system concept. The 5G Architecture – IoT: relation to 5G. **Millimeter Wave Communications:** Spectrum and regulations, Channel propagations, Hardware technologies for mmW systems, Development scenario, Architecture and mobility , Beam forming, Physical layer techniques.

5G Waveforms, Channels, Networking: 5G Radio Access Technologies:
Design principles – Multi-carrier with filtering – Non orthogonal Multiple Access – Radio access for dense deployments – Radio Access for V2X Communication – **5G wireless propagation channel models:** Modeling requirements and scenarios – The METIS channel models. Joint Transmission CoMP enablers – Distributed cooperative transmission – JT CoMP with advanced receivers – Relaying and network coding in 5G: Multi-flow wireless backhauling – Buffer aided relaying.

5G Evaluation & Applications: MTC, D2D Communication, Multi-hop D2D, Multi-

carrier D2D:

Machine-type communications: Fundamental techniques for MTC – Massive MTC – Ultra-reliable low-latency MTC – Device-to-device (D2D) communications – Multi-hop D2D communications – Multi-operator D2D communication – Simulation methodology: Evaluation methodology – Calibration – New challenges in the 5G modeling

IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), BLE, 4G/5G: Frame Structures and applications.

Text Books

1 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, 1st Eidtion.

2 5G Mobile Communications, Xiang, Kan Zheng, Xuemin (Sherman) Shen, Springer 2017.

Reference Text books

1 5G Mobile and Wireless Communications Technology, AfifOsseiran, Jose F. Monserrat and Patrick Marsch, - Cambridge University Press, 2016.

2 Wireless security Handbook, Aaron E. Earle, Tailor and Francis Publication

3 QoS in Wireless Data Networks, https://www.cse.wustl.edu/~jain/cse574-06/ftp/wireless_qos.pdf

Web References

1 Fundamentals of 5G mobile networks, Jonathan rodriguez, - John Wiley & Sons, Ltd, 2015

20EC4064 – Cloud-Computing & Network Security

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Intro. to Cloud Networking: Comp. Networks, Cloud NW, Cloud Data Centers, Virtualization	1,2	2
CO2	Cloud based Big-Data Computing: SW Fabric Arch., Topologies, Cloud Data Center NW, Standards	3,4,5/1	3
CO3	Applications of Cloud-Computing & Security: Cloud Data & IoTs, NW Virtualization, Data Center Sec,	3,4,5/2	3
CO4	Topics in NW Security: Wireless Sec, QoS, Multicast, Web-DNS Sec, Intrusion Detn, DHT Sec]	1,2	2

Syllabus:

Introduction to Cloud Networking:

Basics of Computer Networking and Cloud Networking; Characteristics of Cloud Networking :Ethernet usage, Virtualization, Convergence, Scalability, Software; Data Center Evolution and Mainframes to the Cloud: Enterprise data center networks, Cloud data center networks; Cloud types, Public cloud services, *Cloud Data Center Networking Topologies:* Data Center Network Switch Types, Flat Data Center Networks, Rack Scale

Architectures; Virtualization and Networking: VMware, Edge Virtual Bridging, VM Migration; Network Virtualization: Traditional Network Tunneling Protocols, Virtual Extensible LAN (VXLAN),Network Virtualization using Generic Routing Encapsulation (NVGRE).

Cloud based Big-Data Computing:

Big Data and Cloud Computing Relationship Model: Infrastructure as a Service (IAAS), Platform as a Service (PAAS), Software as a Service (SAAS), Cloud Computing Role for Big Data: IAAS in Public Cloud, PAAS in Private Cloud, SAAS in Hybrid Cloud**.(4 hours)Software Fabric Architecture:** Data Fabric Architecture Fundamentals, basic of Fabric computing, Topology and Key characteristics of Fabric computing, Laying the Foundation for a Data Fabric, Building Data Fabric Capabilities Up and Out, Ecosystem Integration Layer **Cloud Data Center Networks and Standards:** Cloud Data Center Network (CDCNs) Architectures, standards of Data Center Network, Blueprint components of CDCNs, Performance Analysis of CDCNs, Structural robustness and Connectivity of DCNs, Energy efficiency of DCNs, Throughput and average packet delay, Cloud data center reference design. **Data Center security:** Physical Security of DC**,** Restricting Access

Applications of Cloud-Computing (ACC):

Applications of Cloud Computing: Infrastructure as a service (IaaS) and platform as a service (PaaS), Private cloud and hybrid cloud, Test and development, Big data analytics, File storage, Disaster recovery, Backup.**Cloud Computing Security (CCS):**Security issues; CCS Controls; Dimensions & Privacy; Cloud Vulnerability and Penetration Testing; Encryption Algorithm: Attribute-based encryption (ABE), Ciphertext-policy ABE (CP-ABE),Key-policy ABE (KP-ABE),Legal and contractual issues. **Network Virtualization (NV):** Components, External & Internal Virtualization, Performance of Wireless Network Virtualization (WNV)

Network Security:

Risks and Threats of Wireless, Analysis, Spoofing, Denial of service, Malicious Code, Social Engineering, Rouge Access Points, Cell Phone Security, Wireless Hacking and Hackers, RFID**, QoS:** QoS Overview and Background, QoS schemes at the Data Link Layer, QoS Schemes at the Network Layer, QoS Routing Schemes, **Web-DNS Security:** Overview of DNS, Fundamentals of DNS, DNS Transactions, Threats to the DNS, DNSSEC[RFC 2535], Security aware DNS Servers, Security Aware Clients, **Intrusion Detection, DHT Security**

Text Books

Cloud Networking: Understanding Cloud-based Data Center Networks, by Gary Lee, Elsevier

Cloud Computing: Implementation, Management, and Security, John W. Rittinghouse, James F.Ransome

Reference Text books

1 Juniper Networks, Cloud Data Center Architecture Guide

2 Mastering Cloud Computing Fundamentals and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi,

3 Cisco Network Security, A Little Black Book

4 Wireless security Handbook, Aaron E. Earle, Tailor and Francis Publication

5 QoS in Wireless Data Networks, https://www.cse.wustl.edu/~jain/cse574-06/ftp/wireless_qos.pdf

6 Real-Time Traffic over WLAN Quality of Service, https://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Mobility/RToWLAN/CCVP_BK_R7805F20_00_rtowlan-srnd/CCVP_BK_R7805F20_00_rtowlan-srnd_chapter_011.pdf
7 Domain Name System (DNS) Security, By Diane Davidowicz,© 1999 Diane Davidowicz
8 Intrusion Detection Guide, **Sponsors: Bind View, Click net, NAI, ISS, IDC, Cyber Safe, ODS, Tripwire**

Web References

1 http://www.taylorandfrancis.com
2 IP Multicasting: Concepts, Algorithms, and Protocols, https://www.cse.wustl.edu/~jain/cis788-97/ftp/ip_multicast.pdf
3 https://cloud.netapp.com/hubfs/DataFabric/Data%20Fabric%20eBook%20April%202017.pdf?t=1514378378360
4 A Survey of DHT Security Techniques, GUIDO URDANETA, GUILLAUME PIERRE and MAARTEN VAN STEEN VU University, Amsterdam, The Netherlands
5 Cryptography and Network Security, Principles and Practices, Fourth Edition, William Stallings

20EC4065 – IP Multimedia Sub-System & Emerging Technologies

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction. to IMS & IMS Architectures: Next-Gen NWs, IMS Standards, IMS Architectures, IMS Core NW	1,2	2
CO2	IMS Protocol Stacks & IMS Operation: H248, Magcao, RTP, RTCP, IMS to IMS Call/Flow Operation,	3,4,5/1	3
CO3	IMS-PSTN, IMS Services: Comparison of GSM, IMS, PSTN, Web-Msg, Voice Video, VoLTE, RCS	3,4,5/2	3
CO4	Emerging Tech. of IMS &Appn: Cloud, IoT Applications, NFV, SDN, PDAS, DSL, Cable-Set-Top Box]	1,2	2

Syllabus:

Introduction. to IMS & IMS Architectures: Next-Gen NWs, IMS Standards, IMS Architectures, IMS Core NW:

The History of the IMS Standardization-Trends for telephony services, Evolution of mobile networks, Next Generation Networks, IMS, IMS service examples. Origin of IMS,IMS Standards, IMS concepts, IMS Architecture, Core network and Access network Architecture reference models, Components and functions, Control Plane and Data plane in IMS, IMS Interface reference points, User identities

IMS Protocol Stacks & IMS Operation: H248, Magcao, RTP, RTCP, IMS to IMS Call/Flow Operation:

Session Initiation Protocol, DIAMETER and H.248/Megaco, RTP and RTCP, IMS service path. IMS Layer mapping. IMS and the DNS, IMS session setup, IMS registration, IMS call flow examples, IMS to IMS call, IMS Charging, IMS Security, IMS Scenarios, Role of application servers, Examples.

IMS-PSTN, IMS Services: Comparison of GSM, IMS, PSTN, Web-Msg, Voice Video, VoLTE, RCS:

Interoperability between PSTN and IMS, Comparison of PSTN, GSM and IMS networks, Establishing a call with the PSTN. Layer 2 and 3 Messages for call flow. Web Messaging-Voice-Video-VoLTE-Rich Communication Services (RCS) Access Network: Fixed Access Mobile access Wireless access

Emerging Tech. of IMS & Applications: Cloud, IoT Applications, NFV, SDN, PDAS, DSL, Cable-Set-Top Box]:

Trends of IPM based Mobile Phones- Personal Digital Assistants (PDAS)-Desktops/Laptops Digital Subscriber Line (DSL)-Cable Set-Top Box

Text Books

1 The IMS: IP Multimedia Concepts and Services, Miikka Poikselka, Georg Mayer,3rd Edition, Wiley

2 IP Multimedia Subsystem (IMS) Handbook, Mohammad Ilyas, Syed A. Ahson CRC Press

Reference Text books

1 The IP Multimedia Subsystem (IMS): Session Control and Other Network Operations, Ravis Russell, McGraw-Hill

References

1 The 3G IP Multimedia subsystem (IMS)-merging the internet and the cellular worlds, 3rd edition by **Gonzalo Camarillo Ericsson**, **Finland. Miguel A. Garcia-Martin Ericsson, Spain**

BIO-MEDICAL INSTRUMENTATION

20EC4071 – Automated Vehicles & Avionics

L-T-P-S : 3-0-0-0 Credits : 3

Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the fundamentals of comprehensive knowledge on automotive electronics.	**1,2/1**	**2**
CO2	Explore and conjugate the emerging technologies utilized to assist the Autonomous Vehicles.	**1,2/2**	**2**
CO3	Communication and Navigation of automated vehicle using vehicle intelligence.	**1,2**	**2**
CO4	Acquire the basic knowledge on aviation technology.	**1,2**	**2**

Syllabus:

Introduction to Automotive Engineering: Control systems, Vehicle component nomenclature, sensors and instrumentation, introduction to avionics. • Automotive Electronics: Different types of vehicle parameters, basic construction detail ofengine, transmission and suspension systems, Engine Electronics, Transmission Electronics, Infotainment system, Electronic integrated cockpit system, Electronic Ignition system, lighting and accessory system, Electrical Instrumentation, Electronic Throttle control system. • Sensors: Engine speed sensor, Atmospheric pressure and air temperature sensor, Steering system and steering wheel sensor, Oxygen sensor, MAP sensor, MAF sensor, Crankshaft and Cam Shaft position sensor, Coolant temperature sensor, safety sensors.

Automated Vehicle Assisting systems: Active Safety System, Passive Safety System, ADAS, Functional Safety. • Active Safety Systems: Anti Lock Braking System, Traction Control System, Electronic Stability Control ESC, Brake assist. • Passive Safety Systems: Airbag systems, Seat Belt, Occupant Safety System, Child Safety System, Pedestrian Air Bag System. • Advanced Driver Assistance Systems (ADAS): Adaptive Cruise Control ACC, Adaptive Light Control ALC, Blind Spot Monitor, Collision Avoid Monitor, Driver Monitoring System DMS, Lane Change Assistance, Pedestrian Protection system, Tire Pressure monitoring, Traffic Sign Recognition, wrong way driving warning, Automatic Parking system, Hill Decent Control. • Functional Safety: Need for safety systems, Crash Worthiness, Crash Avoidance system

Autonomous Vehicles Technologies: Remote Sensing and Wireless Technology, Automated Vehicle Technology, Vehicle Intelligence. • Remote Sensing and Wireless Technology: Radar and Sonar, Lidar- Multiple Beam, Camera and Night Vision, Wireless System, Integration of GPS technology. • Automated Vehicle Technology: Driverless Vehicle Technology, Navigation System, V2V, V2R, V2I communication, AI and ML. • Vehicle Intelligence: Advance Drive Assistance system, ACC, LAS, SAS, Satellite communication and Telematics. • Communication protocol: Overview of automotive communication protocols, CAN, LIN, Interfacing with infotainment gadgets.

Avionics: Introduction, Construction and Working and Indication System. • Introduction: Construction of aircraft, UAV, RPV. • Flight control systems: Airspeed Indicator, Attitude

Indicator, Compass system, Gyroscopic system, Heading indicator, Turning indicator, Flight director systems, Navigation systems, Auto Pilot System, Very-High Frequency Omnidirectional Range (VOR), Non-directional Radio Beacon (NDB)

Text Books

1 Williams. B. Ribbens: "Understanding Automotive Electronics", 6th Edition, Elsevier Science, Newnes Publication, 2003.
2 Robert Bosch: "Automotive Electronics Handbook", John Wiley and Sons, 2004.

Reference Books

1 Ronald K Jurgen: "Automotive Electronics Handbook", 2nd Edition, McGraw-Hill, 1999
2 James D. Halderman: "Automotive Electricity and Electronics", PHI Publication.
3 Slater J.M., Donnel C.F.O, Onertial Navigation analysis and design, McGraw Hill, New York, 1964.
4 Myron Kyton, Walfred Fried, Avionics Navigation systems, 2nd edition, John Willy & Sons, 1997.
5 Albert D Helfrick, Modern Aviation Electronics: 2nd Ed., PHI, 1994.
6 John S. Duncan, "Pilots handbook of Aeronautical Knowledge", federal Aviation administration.
7 Jack Erjavec, "A systems Approach to Automotive Technology", Cengage learning India Pvt. Ltd.
8 William H Crouse, "Automotive Mechanics", 10th edition, Mc Graw Hill.
9 Dr. Kripal Singh, "Automobile Engineering", Vol.1&2, Standard Publishers

Web references

1 https://www.autonomousvehicletech.com/events/category/66
2 https://www.dspace.com/en/ltd/home/medien/videos/webinarrecords/webinarrec_sensorsim.cfm
3 https://www.mcca.com/wp-content/uploads/2018/04/Autonomous-Vehicles.pdf
4 https://www.youtube.com/watch?v=1lUkyCYdAEY
5 https://www.youtube.com/watch?v=tiwVMrTLUWg
6 https://www.youtube.com/watch?v=OlLFK8oSNEM

20EC4072 – Calibrations and Designing Advanced Instruments

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basic parameters of instruments and their calibration.	**1,2**	**1**
CO2	Explore the Generations of instruments	**1,2/1,2**	**2**
CO3	Investigate the Calibration process	**1,2**	**2**
CO4	Interpreting Advanced Instruments, reliability & safety	**1,2**	**2**

Syllabus:

Instruments and Calibration Basics: Measures, Units, Standards, Precision, Accuracy, Error, Repeatability, International Standards, national Standards, Echelons, Calibaration Concepts.
Generations of instruments: First, Second, Third, Fourth and Fifth generation Instruments Accuracy, Sensitivity, Precision, DVMs, DAMs, DMM of 3,4,5,5.5 Digit.

Calibration process, Methods and Certification: Mechanical, Fire and Safety systems, Electrical Systems, Electronics Instruments, Calibration period ,Certification levels, Radar Beam/Lobe Calibration procedure, documentation and certification etc.
Designing Advanced Instruments: Increasing precision, accuracy, reliability & safety etc. SYSTEM RELIABILITY CONCEPTS : Basic Probability Theory, Network Modeling and Reliability Evaluation , Time Dependent Probability, Multi Component & Approximate System Reliability Evaluation-RELIABILITY IN ENGINEERING DESIGN Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis (FTA), Product Liability and Planning, Product Development Process. Safety Instrumented System: function, architecture, safety life cycle, Application of safety system.

Text Books

1. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), DhanpatRai & Co. Pvt. Ltd., 2004.
2. Doebelin, E.O. and Manik, D.N., "Measurement systems Application and Design", 6th McGraw-Hill Education Pvt. Ltd, 2011,
3. B.G.Liptak, "Instrumentation Engineers Handbook (Process Measurement & Analysis)", Fourth Edition, Chilton Book Co, CRC Press, 2005.

Reference Books

1. "Electronic Instrumentation", H. S. Kalsi, TMH, 2004,Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), DhanpatRai& Co. Pvt. Ltd., 2004

20EC4073 – Biological & Cyber-Physical Systems

L-T-P-S : 3-0-0-0 — Credits : 3
Pre-requisites : NIL — Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basic parameters of Cyber-Physical systems.	**1,2**	**1**
CO2	Explore various types of Cyber-Physical systems.	**1,2/1**	**2**
CO3	Interfacing of Biology with Silicon technology.	**1,2/2**	**2**
CO4	Interpreting Various Advanced technology with some case studies.	**1,2**	**2**

Syllabus:

Introduction to Cyber-Physical Systems: Definition, Electro-mechanical smart system: GPS chips, light sensors, proximity sensors, IT/Internet/Wifi enabled hardware based systems: WiFi, 4G, EDGE, Bluetooth, Major constituents, Microcontroller boards: Arduino, RaspberryPi.

Various Types of Cyber-Physical Systems. (i) IOT Application: The Open Web Application Security Project's (OWASP).(ii) Utilization-wise categorization: Home, Industry, Security, Defence, Space etc (iii) Role-wise categorization: repair-purpose, assistive, creative, human-capacity enhancement/replacement.

Biological and Silicon Interfaces: Artificial neural networks: Biological neural networks, model of an artificial neuron, Activation functions, architectures, characteristics learning methods, brief history of ANN, ANN architectures. Biologically inspired artificial devices: Prosthetic limbs, Artificial Heart and circulatory assist devices, artificial lungs, artificial muscle. Challenges and issues Artificial vision: Computer vision – word recognition, feature extraction based on biological visual system, stereo vision; speech recognition.

Misc. Topics and case studies: Unmanned Aerial Vehicle (UAV): Why UAV, Case study: Current UAV , MQ-1 Predator, RQ-2B Pioneer, RQ-4 Global Hawk, Remotely Piloted Vehicles(RPV): Case study-FALCON from DRDO, Unmanned Marine Vehicle(UMV): Future direction, Comparison with UGV

Text Books

1 Dynamical Model in Biology; Author: M Farkas; Publisher: Academic Press.
2 Biorobotics; Author: B Webb, T R Consi; Publisher: AAAI Press
3 Insectronics ; Author: Karl Williams; Publisher: Mc Graw Hill.
4 Amphoibionics: Built Your own biologically Inspired Reptilian Robot; Author: Karl Williams; Publisher: Mc Graw Hill.

Reference Books

1 R. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India, New Delhi, 2003

20EC4074 – Electronic Instruments & Biomedical Applications

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the fundamentals of Electronic Instrumentation	**1,2**	**2**
CO2	Explore the Electronics Instruments and Buses [range of instruments and their connectivity in a rack-mount using different buses),	**1,2/1**	**2**
CO3	interpret the basics of Biomedical Electronics,	**1,2/2**	**2**
CO4	Applications of Bio-medical Electronics (Ex: IoT in healthcare, remote robotic controlled operations, tele-medicine, Medical Electronics Instruments etc.]	**2,4**	**2**

Syllabus:

Fundamentals of Electronic Instrumentation: Fundamentals of Electronic Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis. Calibration - Primary and secondary standards. Sensors and measurements: Active and passive transducers, Resistance, inductance and capacitor measurements. Strain Gauge: LVDT, RTD, Thermistor, thermo couple etc.

connectivity in a rack-mount using different buses]

Analog and digital measuring Instruments: Ohm meter, AC/DC Ammeter and Voltmeters. CRT: Measurements of Voltage, current, phase and frequency, Signal generators, sweep generators.

ADC, Signal conditioning, Instrumentation Amplifiers, Digital instruments: Digital Multimeter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer,

Digital pH meter, Digital capacitance meter. Interfacing buses.
Basics of Biomedical Electronics: Overview of Medical Electronics Equipments, classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these instruments. 4P
Bio-Electrodes Bioelectric signals, Bio electrodes, Electrode, Electrode tissue interface, contact impedance, Types of Electrodes, Electrodes used for ECG, EMG and EEG. 6P

Applications of Bio-medical Electronics [Ex: IoT in healthcare, remote robotic controlled operations, tele-medicine, Medical Electronics Instruments etc.]
Bio Medical Recorders, Patient Monitoring Systems ,Heart rate measurement, Pulse rate measurement, Respiration rate measurement, Blood pressure measurement ,Principle of defibrillator and pace marker.

Safety Aspects of Medical Instruments: Gross current shock, Micro current shock ,Special design from safety consideration ,Safety standards.

Text Books

1 1. A.K.Sawhney,―Electrical & Electronics Measurement and Instrumentation‖,10th edition, DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2 Leshie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, PHI, 2003.
3 John G. Webster, Medical Instrumentation: Application and Design, 3rd edition, John Wiley &Sons, New York, 1998

Reference Books

1 R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009.
2 Handbook of biomedical Instrumentation by RS Khandpur

20EC3072 – Autonomous Vehicles & Automotive Electronics

L-T-P-S : 3-0-0-0 Credits: 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Autonomous Vehicles, dynamics and design electronics to complement those features.	1,2/1	2
CO2	To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms. To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software	1,2	3
CO3	To understand the concepts of Automotive Electronics and its evolution and trends. Automotive systems & subsystems overview	1,2/1	3
CO4	Design and implement the electronics that attribute the reliability, safety, and smartness the embedded to	1,2	2

	Automotive Electronics protocols and autonomous Vehicles testing, vibration.		

Syllabus:

(i)Introduction to Autonomous Vehicles [4-5]

Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Vehicle Operating Software; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Society of Automotive Engineers Levels of Automation; Major Functions of physical Ecosystem of an Autonomous Vehicle (cameras, radar, lidar, gps, ultrasonic sensors, central computer, DRSC-based Receiver); Autonomous Vehicle architecture (JAUS & GOA);

(ii) Driver Assisted/Driverless Vehicles, Connected Vehicles: [4-5]

Basic control system applied to Drive Assisted, Driverless, Connected Vehicles; Overview of the operation of Electronic Control Unit (ECUs); Basic cyber-physical system theory and autonomous vehicles; Comparison chart of deriver assisted vs driverless vehicle and connected Vehicles vs Autonomous Vehicles.

Automotive Sensors [4-5]

Role of sensors and actuators in autonomous vehicles; Schematic principle of Autonomy and automotive sensors; Sensor characteristics**,** Hall phase, Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Exhaust gas oxygen concentration, Throttle plate angular position, Crankshaft angular position/RPM, Manifold Absolute Pressure (MAP), Differential exhaust gas pressure and Air bag sensors, Sensor Testing and Calibration **Automotive Actuators (AA) :** Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Transmission (AT) [4-5]: Transmission fundamentals, Types MT, AT, CVT and DCT, ATS, Clutch, characteristic studies of Gear Box, epicyclic gear arrangement. **Microcontrollers for Automotive (AM):** Criteria to choose the right microcontroller/processor for various automotive applications; Understanding various architectural, Dynamometer testing. Vehicle Control, Power train, Driver Information, Motor Control Technologies: Toshiba offers microcontrollers, Vector Engine (VE), Automotive MCU

Automotive Control System & Model Based Development [1-2]: Control system approach in Automotive Electronics, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE toolboxes.

Automotive Electronics (AE) [4-5]

Fundamentals of Automotive Electronics (FAE): Principles of automotive systems **Advanced driver-assistance systems (ADAS):** Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, ADAS in Toyota, Nissan, Honda, Hyundai, Volkswagen, BMW, General Motors. **Bluetooth low energy and the automotive (BLE-AE):** Functional view of BLE; BLE-enabled Vehicle access block diagram; operation of Smart vehicle access using BLE, Driver assistance and personalization using BLE-AE, Piloted/assisted/remote parking BLE-AE.

Automotive Wireless (AW)[4-5] : Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Wireless Access in Vehicular Environments (WAVE) amendment to IEEE 802.11; IEEE 802.11ac WLAN PHY and dual-band (2.4 GHz/5 GHz) support ; EEE 1609 - Family of Standards for Wireless Access in Vehicular Environments (WAVE). **Automotive GPRS Vehicle Tracking (AGPRS-VT)** Vehicle Tracking System; Principle of working for Vehicle Tracking system. GPS and GPRS tracking system

Embedded to Automotive Electronics and autonomous Vehicles [4-5]:

Controlled Area Network (CAN): Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication. **Local Interconnect Network (LIN) :** Basic, LIN workflow concepts, LIN frame, header concepts, IN Checksum Calculation and Verification, applications.

FlexRay Consortium [5-6]: Basics, Working, Clock synchronization, Single Edge Nibble Transmission) protocol: SENT protocol structure, Basic Concepts and Fast Channel Data Transmission, **Media Oriented Systems Transport (MOST):** Principles of communication operations, Competing standards. **Vehicle Area Network (VAN):** basic architecture of VAN, operational view of VAN, Integrated to Automotive Electronic Protocols: EBD, Electronics stability programs (ESP), PA Industrial control system protocols: Open Platform Communications (OPC), Remotely Piloted Vehicles (RPVs); Unmanned Aerial Vehicle (UAV). **Manifold Absolute Pressure Sensor (MAP sensor):** Basic architecture, operation, applications, testing procedure of MAP. Electronic Control Units (ECU), Vehicle Networking & Diagnostics Stacks; Automotive Functional Testing: The Process Flow-diagram. HIL Testing, MIL Testing, SIL Testing.

Text Books

1 Crating Autonomous Vehicle Systems by shaoshan liu, liyun li

2 Autonomous vehicles: opportunities, Strategies, and Disruptions by Michael McGrath

3 Reinventing the automobile: personal urban mobility for the 21st century (the MIT Press) by William J. Mitchell, Chris E. Borroni-Bird, Lawrence D. Burns.

4 Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System” Prentice Hall Inc., New Jersey

5 Understanding Automotive Electronics an Engineering Perspective Seventh edition William Ribbens.

6 Automotive Power Transmission Systems Yi Zhang University of Michigan-Dearborn USA Chris MiSan Diego State University USA.

7 Automotive Embedded Systems Handbook CRC Press Taylor & Francis Group Richard Zurawski

8 Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive Robert Bosch GmbH (Ed.) 5th Edition

9 William B Ribbens "Understanding Automotive Electronics", SAE Publications, 1998

Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006.

10 Marc E. Herniter and Zac Chambers: “Introduction to Model Based System Design”, RoseHulman Institute of Technology. Rudolf Limpert, “Brake design and Safety”. SAE Publications, 2015,

Web References

1 https://toshiba.semicon-storage.com/ap-en/product/automotive/micro.html
2 https://www.tesla.com/autopilot
3 https://www.audi.com/en/experience-audi/mobility-and-trends/autonomous-driving.html
4 https://global.toyota/en/mobility/
5 https://www.mazdausa.com/

20EC3075 – Human Machine Interface & Brain Machine Interface

L-T-P-S : 3-0-0-0 Credits : 3
Pre-requisites : NIL Contact Hours : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics.	**1,2**	**1**
CO2	Understanding the HMI Technologies such as GMOS Models, CMN-GOMS, Fitts Laws, Hick-Hyman Laws, Norman's 7 Principles.	**1,2/1**	**2**
CO3	Understanding the concept of Brainwaves & BMI	**1,2/1**	**2**
CO4	Analysing Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FEM]	**1,2**	**2**

Syllabus:

(a) Intro. to HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics

Introduction to the course and to HMI/HCI, HMI/HCI Its history Relation to Ergonomics and Human Factors Problems and challenges Recurrent HMI Themes, Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques.

Design rules Authority vs. generality Principles, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS, Fitts' law and Hick-Hyman's law, Guidelines in HCI: Norman's seven principles, Norman's model of interaction, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough.

(c) Brainwaves & BMI: Alpha, Beta, Theta, Gamma wave, Brain-Control Interface, ARMA Model

Introduction to ***Brain Control Interface*** Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI Brain signal acquisition, Experiment design and data analysis (with explanation of one-way ANOVA), ARMA Model

(d) Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FSM] Task modelling and analysis through Hierarchical task analysis (HTA), GUI design for a mobile phone based Matrimonial application, Employment Information System for unorganized construction workers on a Mobile Phone. Dialog Design using FSM (finite state machines), Cognitive architecture, Object Oriented Modelling of User Interface Design.

Text Books:

3. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
4. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.

Reference Books:

1. B. Schneiderman; Designing the User Interface, Indian Reprint, Addison Wesley 2000.
2 Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012

Web References

1 https://www.expertsnotes.com/2016/04/jntuk-r-10-4-2-cse-human-computer.html
2 https://nptel.ac.in/courses/106103115/4
3 http://www.eolss.net/sample-chapters/c18/e6-43-37-06.pdf
4 https://www.Tutorials.in/How_Does_Your_HMI_Design.
5 Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006

20TS3202- Technical Proficiency / Technopreneurship

L-T-P-S	: 0-0-0-12	Credits : 3
Pre-requisites	: NIL	Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Learning the Domain based tool and understanding the real time applications	PO1	2
CO2	Understanding the tool for basic operational applications	PO2	2
CO3	Understanding the tool for Minor Projects (Real time applications)	PO2	2
CO4	Applying the domain based tool for project developments which can be used as a product	PO3	3

Syllabus : Wireless communications: Getting started with HFSS, Antenna Design and Simulation, Advance antenna design – Guidelines and Design case studies, BER Performance in AWGN channel (GMSK, MSK, OQPSK) using Simulink, BER performance of BPSK in AWGN with different block codes using Simulink, BER Performance in AWGN with various fading channels using Simulink. IoT: Introduction to IoT, Explanation of different Types of sensors in IoT, Types of Actuators used in IoT devices, Different types of communication modules used in IoT with examples, Cloud services for IoT, Cloud Data analysis, Case study - smart home automation, Case study -smart buildings (Institutions and offices), Case study - Role of IoT in industry 4.0 (Industry Expert Interaction), Case study -Role of IoT in covid (Expert person Interaction). Data Communications: Design OFDM Transmitter and Receiver using Matlab Simulink, Design of 5G FMCW using Matlab Simulink, Design and simulation of cloud-based data communications using Matlab/Python, Design and simulation of online based data communication agents using Matlab/Python, Design and simulate vehiclebased data communications Matlab/Python. BMI: Introduction to Biomedical Instrumentation, Overview of Biomedical Instrumentation, Classification of Biomedical Instrumentation, General constraints in Design of Medical Instrumentation systems, Design of biomedical instruments using Proteus tool, Design and simulation of patient monitoring systems, Design and simulation of Covid-19 related projects, Projects based on Proteus design and simulation. VLSI: Digital circuit simulation, Layout Extraction, Parasitic values estimation from layout, Layout Vs Schematic, Net List Extraction, Design Rule Checks. Software: Xilinx ISE Suite 13.2 Version, Mentor Graphics-Questa Simulator, Mentor Graphics-Precision RTL, Mentor Graphics Back End/Tanner Software tool, Mixed Signal simulator. AI/ML: Speech processing and modeling on sample data, K means algorithms and models on different data set(Machine learning), Data Fundamentals and Hadoop Integration, Predictive Analytics and segmentation using Clustering Implementation of decision tree model, Image processing using python, Filter circuits design and node analysis using python (Power and Voltage calculations).

Text Books :

1. Communication Systems Modeling and Simulation Using MATLAB and Simulink by Ms Sreelatha Menon, CRC Press (Taylor & Francis).
2. Precision: Principles, Practices and Solutions for the Internet of Things" by Timothy Chou,
3. Artificial Intelligence: A Modern Approach (Pearson Series in Artifical Intelligence) 4th Edition by Stuart Russell
4. Verilog Digital System Design, Z. Navabi, McGraw Hill Education 2nd Ed. 2008

Web Links :https://www.xilinx.com/support/download.html https://store.digilentinc.com/ https://www.youtube.com/watch?v=0mvsFweINeY

MOOCS : Hardware Description Languages for FPGA Design https://www.coursera.org/lecture/fpgahardware-description-languages/introduction-to-hardware- description-languages-for-fpga-design-JoMWp

20TS3101- Technical Proficiency / Entrepreneurial Incubation

L-T-P-S : 0-0-0-12 Credits : 3

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO 1	Learning the Domain based tool and understanding the real time applications	PO1	2
CO 2	Understanding the tool for basic operational applications	PO2	2
CO 3	Understanding the tool for Minor Projects (Real time applications)	PO2	2
CO 4	Applying the domain based tool for project developments which can be used as a product	PO3	3

Syllabus

VLSI Design: 1.Introduction to EDA tools. 2.CMOS circuit design. 3.Design and verify the

functionality of CMOS Logic gates. 4.Design and verify the functionality of Boolean expression. 5.Design and verify the layout of CMOS Logic gates.
Data Science: 1.Linear regression and regularization experiment on sample data. 2.K means algorithms and models on different data set. 3.Data Fundamentals and Hadoop Integration with R. 4.Predictive Analytics and Segmentation using Clustering 5.Implementation of decision tree model
Wireless Communication: 1.Introduction to wireless communication and MATLAB 2.Analysis and simulation of path loss models for wireless communication. 3.Design and simulation of SISO. 4.Design and simulation of MISO. 5.Simulation of basic OFDM
Embedded & IOT: 1.Introduction to TINKERCAD and ARDUINO. 2.Introduction to Internet of Things. 3.Communication with cloud (Thingspeak). 4.Monitoring Home appliances using IoT 5.Controlling devices using IoT Environment

20TS4103- Technical Proficiency / Entrepreneural Skilling

L-T-P-S : 0-0-0-12 Credits : 3
Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Learning the Domain based tool and understanding the real time applications	PO1	2
CO2	Understanding the tool for basic operational applications	PO2	2
CO3	Understanding the tool for Minor Projects (Real time applications).	PO2	2
CO4	Applying the domain based tool for project developments which can be used as a product	PO3	3

Syllabus :1. Design and verify the schematic of CMOS Logic gates 2. Design and verify the schematic of CMOS Special gates 3. Design and verify the schematic Boolean Expression 4. Design and verify the layout of CMOS Logic gates 5. Design and verify the layout of CMOS Special gates 6. Design and verify the layout of SR Latch 7. Design and verify the layout of Half Adder 8. Design and verify the schematic of 1-bit SRAM cell. 9. Design and verify the layout of Ring oscillator using 5 NOT gates (or)
1. Loan Prediction Data : Predict if a loan will get approved or not. 2. Time Series Analysis Data : Specific to time series and the challenge here is to forecast traffic on a mode of transportation. 3. Heights and Weights Data: Predict the height or weight of a person. 4. Bigmart Sales Data: Predict the sales of a store. 5. ImageNet Data: object detection, localization, classification and screen parsing. (or)
1. Design and simulation of the M-ary PSK Using Matlab/Simulink for Rayleigh fading with AWGN. 2. Simulation of the power received at the receiver w.r.t to the distance for different path loss exponents. 3. Design and simulation of multipath signal reception with equalizer and without equalizer for different path delays 4. design and study the performance of SISO and SIMO using MATLAB 5. Simulation of basic OFDM 6. Performance Analysis of Various Modulation Techniques in Rayleigh and Rician Wireless Channel Models (or)
1. Sense the temperature of the living room. 2. Monitor gas leakagein building 3. Identify the humidity of remote location with the help of IoT 4. IoT based human interaction detection in a location. 5. Store the soil moisture data in cloud using IoT.
Web Links :

https://www.tinkercad.com/things/6UWaknlDyk3-terrific jaiks/editel?tenant=circuits
https://towardsdatascience.com/top-9-data-science-projects-for-a-beginner-in-2020-26eb7d42b116
https://www.elprocus.com/wireless-communication-project-ideas/
https://www.pantechsolutions.net/blog/top-100-vlsi-projects-with-source-code/

20TS4204 - Technical Proficiency / Entrepreneural Skilling

L-T-P-S	: 0-0-0-12	Credits	: 3
Pre-requisites	: NIL	Contact Hours	: 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Learning the Domain based tool and understanding the real time applications	PO3,PO5	2
CO2	Understanding the tool for basic operational applications	PO5,PO3	2
CO3	Understanding the tool for Minor Projects (Real time applications)	PO3,PO5	2
CO4	Applying the domain-based tool for project developments which can be used as a product	PO3,PO5	3

Syllabus : Wireless communications: Getting started with HFSS, Antenna Design and Simulation, Advance antenna design – Guidelines and Design case studies, BER Performance in AWGN channel (GMSK, MSK, OQPSK) using Simulink, BER performance of BPSK in AWGN with different block codes using Simulink, BER Performance in AWGN with various fading channels using Simulink. IoT: Introduction to IoT, Explanation of different Types of sensors in IoT, Types of Actuators used in IoT devices, Different types of communication modules used in IoT with examples, Cloud services for IoT, Cloud Data analysis, Case study -smart home automation, Case study -smart buildings (Institutions and offices), Case study -Role of IoT in industry 4.0 (Industry Expert Interaction), Case study -Role of IoT in covid (Expert person Interaction). Data Communications: Design OFDM Transmitter and Receiver using Matlab Simulink, Design of 5G FMCW using Matlab Simulink, Design and simulation of cloud-based data communications using Matlab/Python, Design and simulation of online based data communication agents using Matlab/Python, Design and simulate vehicle-based data communications Matlab/Python. BMI: Introduction to Biomedical Instrumentation, Overview of Biomedical Instrumentation, Classification of Biomedical Instrumentation, General constraints in Design of Medical Instrumentation systems, Design of biomedical instruments using Proteus tool, Design and simulation of patient monitoring systems, Design and simulation of Covid-19 related projects, Projects based on Proteus design and simulation. VLSI: Digital circuit simulation, Layout Extraction, Parasitic values estimation from layout, Layout Vs Schematic, Net List Extraction, Design Rule Checks. Software: Xilinx ISE Suite 13.2 Version, Mentor Graphics-Questa Simulator, Mentor Graphics-Precision RTL, Mentor Graphics Back End/Tanner Software tool, Mixed Signal simulator. AI/ML: Speech processing and modeling on sample data, K means algorithms and models on different data set(Machine learning), Data Fundamentals and Hadoop Integration, Predictive Analytics and Segmentation using Clustering Implementation of decision tree model, Image processing using python, Filter circuits design and node analysis using python (Power and Voltage calculations).

Text Books :1. Communication Systems Modeling and Simulation Using MATLAB and Simulink by Ms Sreelatha Menon, CRC Press (Taylor & Francis). 2. Precision: Principles, Practices and Solutions for the Internet of Things" by Timothy Chou, 3. Artificial Intelligence: A Modern Approach (Pearson Series in Artifical Intelligence) 4th Edition by Stuart Russell 4. Verilog Digital System Design, Z. Navabi, McGraw Hill Education 2nd Ed. 2008

Web Links :

https://www.xilinx.com/support/download.html
https://store.digilentinc.com/
https://www.youtube.com/watch?v=0mvsFweINeY

MOOCS :

1. Hardware Description Languages for FPGA Design https://www.coursera.org/lecture/fpga-hardware-description-languages/introduction-to-hardware-description-languages-for-fpga-design-JoMWp

20EC1202 – COMPUTER ORGANIZATION AND ARCHITECTURE

L-T-P-S : 2-0-0-0
Credits : 2
Contact Hours : 2
Pre-requisite : 20EC1101

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the functionality and design the CPU functional units - control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.	**1,2**	**2**
CO2	Understand, analyze and design main, cache and virtual memory organizations.	**1,2**	**2**
CO3	Understand, analyze and design different types of I/O transfer techniques.	**1,2**	**2**
CO4	Understand the design issues of RISC and CISC CPUs and the design issues of pipeline architectures.	**2,3**	**2**

Gist: (a) Number representations, ALU, Assembly, HLL, Moore, Mealey, Van-Neuman architecture, (b) CPU Design, Cache & Virtual memory, (c) I/O, DMA, storage, buses, data-transfer, (d) Pipelining, RISC, CISC parallelism.

Syllabus: Computer Architecture, Computer system and its sub modules: State Diagram various Architectures, Moore Machine, Mealey Machine, Van Neuman architecture and hardware implementation of Arithmetic and Logic Unit, Buses Types, Specifications of a computer, Concepts of Machine level programming, Assembly level programming and High-level programming. Various addressing modes and designing of an Instruction set. Concepts of subroutine and subroutine call, use of stack for handling subroutine call and return.

CPU Design: Introduction to CPU design, Instruction interpretation and execution, Micro-operation and their RTL specification. Hardwired control CPU design. Micro programmed control CPU design. Concepts of semiconductor memory, CPU-memory interaction, organization of memory modules. Cache memory and related mapping and replacement policies. Virtual memory, paging concepts, VAS to PAS and Vice-versa mapping.

Input / Output Devices: Introduction to input/output processing, working with video display unit and keyboard and routine to control them. Program controlled I/O transfer. Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Introduction to buses and connecting I/O devices to CPU and memory, TRAP and Interrupts.

Pipelining: Introduction to RISC and CISC paradigm. Design issues of a RISC processor and example of an existing RISC processor. Introduction to pipelining and design issues of pipeline architecture. Introduction to parallel computing.

Text Books
1 William Stallings, Computer Organization and Architecture: Designing for Performance, 8/e, Pearson Education India. 2010.
2 D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 4/e, Morgan Kaufmann, 2008.
Reference Books
1 V. C. Hamacher, Z. G. Vranesic and S. G. Zaky, Computer Organization, 5/e, McGraw Hill, 2002
2 Morris Mano, Computer System Architecture, 3/e, Pearson, 2008.
Web References
1 NPTEL Computer Organization and Architecture Lecture by IIT Guwahati. https://onlinecourses.nptel.ac.in /noc19_cs04/

2 MOOCS:https://www.edx.org/course/computation-structures-3-computer-mitx-6-004-3x-0

20EC1213 – DESIGN OF BASIC ELECTRONIC CIRCUITS

L-T-P-S : 3-0-0-0
Credits :3
Contact Hours :2
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic electronic components.	**1**	**1**
CO2	Understanding of junction diode, I-V characteristics and applications of diodes.	**1**	**1**
CO3	Understanding the design and working of power supply and regulators using zener diodes.	**1**	**1**
CO4	Understand the working of BJT and study of data sheets, analog and digital IC's.	**5**	**1**

Gist: Diodes & Transistors, Regulators & Power supply circuit, Thevenin & Norton Theorem.

Syllabus: BASIC ELECTRONIC COMPONENTS:
Introduction to Electronic Components: Components, types of components, color coding, types of resistors, types of capacitors, types of inductors, switches, diodes, transistors, Induction coils, transformers.
Introduction to Circuit Theory: Mesh analysis, Nodal Analysis, Thevenin's theorem, Norton's theorem, Super position theorem, Maximum power transfer theorem.
Diodes: P-type and N-type semiconductors (brief discussion), P-N junction, forward bias and reverse bias, V-I characteristics, ideal and practical diodes, approximate model, diode data sheet, types of diodes and variants (Introductory level only).
Applications of diodes: Clippers, Clampers, Rectifiers - HWR, FWR, BR with and without capacitive filters.
POWER SUPPLY & TRANSISTER BASICS:
Power supply: Power supply with ripple reduction and regulation.
Zener Diode: Difference between ordinary diode and zener diode, zener diode as a voltage regulator, Avalanche and Zener breakdown, Zener characteristics, Applications.
BJTs: Types of transistors (PNP and NPN), switching transistors, power transistors (low, medium and large power), key parameter from data sheet. (Gain, Bandwidth, β,α...etc.
Analog & Digital ICs: 7805,7905,IC 741, IC 555, LM 339, LM723.

Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell

Reference Books

1 Integrated Electronics by Millman & Halkias

20EC2111 –ELECTRONIC SYSTEM DESIGN WORKSHOP

L-T-P-S : 1-0-2-2
Credits : 2.5
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Capable to understand the electronic system design process, analyze the heat management system and understand the soldering techniques.	**1,5**	**2**
CO2	Able to understand PCB fabrication process, PCB artwork and various protection methods for electronic systems.	**1,3,5,7**	**2**
CO3	Able to understand Raspberry Pi microcontroller and its applications	**1,3,5,7**	**4**
CO4	Able to understand product making steps, the noise reduction designs in components & circuits, high frequency designs and CAD packages	**1,5**	**2**
CO5	Recognizing the software tool and PCB fabrication steps to implement an electronic system. Recognizing the software tool and Raspberry Pi microcontroller board to implement a few specific applications.	**11**	**4**

Gist: PCB Design, Fabrication, Raspberry-Pi Boards, Embedded Circuits Application Design hands-on

Syllabus:

(a) Design Process and Its Fundamentals; Product Life Cycle, Electrical/RF safety; Technical Drawings, Circuit Diagrams; Electronic Systems and Classifications: Examples and case studies;

(b) Heat Management and Cooling by using Heat Sinks, Soldering Techniques.

(a)PCB Making: PCB Artwork using PC software, Design and of Multilayer PCBs, SMDs and mounting techniques.

(b)Protection: Grounding, Shielding; Balancing and Filtering; EMI / EMC/ ESD Protections; Cabling and Connectors; Panel Layout Ergonomics.

(a) Introduction to Raspberry Pi microcontroller board

(b) Developing applications using Raspberry Pi microcontroller board (a)Electronic System Design implementations analog, digital (TTL/ CMOS) and Microcontroller systems; Opto isolators, Relays and Displays, A to D and D to A converters, RAM Data Storage and retrieval, Data Generators

(b)Applications and Product making

Testing, Packaging, manufacturing, recycling and Environmental Compliance, Design for: Low noise, EMI/EMC compatibility, High frequency designs, PTH, CAD Packages

Text Books

1 Fundamentals of Electronic Systems Design by Jens Lienig, Hans Bruemmer ISBN 978-3-319-55839-4 ISBN 978-3-319-55840-0 (eBook), © Springer International Publishing AG 2017
2 Learning the Art of Electronics – A hands-on lab course Thomas C Hayes with the assistance of Paul Horowitz
3 Electronic Instrument Design, 1st edition; by: Kim R.Fowler; Publisher: Oxford University Press, 2015.
4 ELECTRONICS- A systems Approach 4th Edition by Neil Storey ISBN: 978-0-273-71918
5 PRINTED CIRCUIT BOARDS - Design, Fabrication, Assembly and Testing by Dr R S Khandpur
6 Raspberry Pi Cookbook by Simon Monk, Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.
7 Noise reduction techniques in electronic systems by Henry W Ott

Reference Books

1 Printed Circuit Boards - Design & Technology, 1st edition; by: Walter Bosshart; Tata McGraw Hill
2 David a. Bell electronic devices and circuits 5th edition.
3 Karl. T. Ulrich, Steven D. Eppinger, " Product design & development", Mc Graw Hill Companier 5th edition
4 Electronic Product Design, R.G.Kaduskar, V.B.Baru, Wiley India 2nd edition

20EC2214 –IOT DESIGN WORKSHOP

L-T-P-S : 1-0-0-4
Credits :2
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding and Designing IOT applications with NODE MCU and Arduino.	**1,2**	**1,2**
CO2	Study of Raspberry Pi with different communication module to design IOT applications	**1,2**	**3**
CO3	Designing of Web Page, control and analyze sensor data through it	**1,2**	**3**
CO4	Understanding the inbuilt protocols and IOT management with STM 32.	**2,4**	**3**

Syllabus:

IoT Applications & Sensors: Analog & Digital sensors, MPU 6050, MCP2515(CAN), DS2321 (RTC), Applications Interfacing to IoT : Micro controllers boards, ESP8266, Peripherals (Motors, Camera, Speaker, Displays), Controlling through Mobile & Web

IoT Data Communication: Wi-Fi Protocols, Bluetooth, BLE, WSN, Zigbee, RFID, NFC, Client Server, Cloud. Protocols & Case Studies : Issues & Challenges : Security, Privacy, Scalability, Store and Analytics Case Studies: Health, Smart cities, Village/ Agriculture

Text Books

1 Internet of Things a hands-on Approach by Arshdeep behga and Vijay madisetti ,Orient Black Swan Publications.

Web References

1 https://www.eventshigh.com/detail/chennai/33e6f1710a75921963a8e81f394c4f5b-internet-of-things-iot-workshop
2 https://www.skyfilabs.com/iot-courses-and-workshops
3 https://www.youtube.com/watch?v=SiU-QZwik8w
4 https://www.youtube.com/watch?v=p82vmuJqu-8
5 https://www.youtube.com/watch?v=bOsjfixX_lk
6 https://www.youtube.com/watch?v=9ev3xTDEhtw

20EC2112 – IT WORKSHOP

L-T-P-S : 1-0-2-0
Credits :2
Pre-requisite : NIL

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Experiment with architectural design of a computer with various basic concepts of operating systems and provides solution to PC Hardware and Software problems	PO2, PO3	3
CO2	Identify the basic peripherals and assemble the PC with OS installation	PO3, PO4	3
CO3	Construct connection for the PC on to the internet from home and workplace with effective usage of the internet, Usage of web browsers, email, newsgroups and discussion forums.	PO3, PO5	3
CO4	Experiment with cases designed using office tools and latex	PO6	3

SYLLABUS:

PC Hardware – Software – OS Installation - Troubleshooting - Internet and World Wide Web – Web Browsers – Search Engines – Develop Home Page - Software Productivity Tools – Ms Word – Mail Merge - Spreadsheet Orientation – Microsoft Excel – Powerpoint - Latex – Project – News Letter – Documentation

TEXT BOOKS:

1. IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfinson and Ken Quamme. – CISCO Press, Pearson Education.
2. Microsoft Office Word by TorbenLageFrandsen, Ventus Publishing ABS, 2010
3. Latex Begineer's Guide by Stefan Kottwiz, Packt Publishing, 2011

REFERENCE BOOKS:

1. LaTeX Companion – Leslie Lamport, PHI/Pearson.
2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
3. Comdex Information Technology course tool kit Vikas Gupta, WILEY Dreamtech
4. PC Hardware and A+ Handbook – Kate J. Chase PHI (Microsoft)

19EC2103 – ANALOG ELECTRONIC CIRCUIT DESIGN

L-T-P-S : 3-0-2-2
Credits : 4.5
Contact Hours : 7
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study of BJT's and Various application in Amplifiers	**1,3**	**2**
CO2	Understand various types of FET's, IC Types and analyze FET as an Amplifier	**1,3**	**2**
CO3	Understand the Linear & Non-linear application of Op-AMP and analyze active filters	**1,3**	**2**
CO4	Analysis of different types of oscillators, filter and regulators.	**1,3**	**4**
CO5	Design and Testing of Analog circuits for realistic applications	**5**	**4**

Gist: (a) BJTs: h-parameters, equivalent representation, biasing, feedback & power amp, (b) FETs & MOSFETS, (c) Op-Amps, Schmitt Triggers, CMRR, IC 741, Oscillators, (d) Timer IC 555, Multi-vibrators, Filters (1st & 2nd Order), Regulators ICs and PLL.

Syllabus:

Transistor Amplifiers: BJTs: Biasing, types of biasing, h-parameters, equivalent representation of a transistor using h - parameter model, self bias design, amplifier design from biasing, amplifier analysis using h-parameters (Gain, Bandwidth, input and output impedances), Design of a CE amplifier. Negative feedback amplifiers: need for negative feedback, feedback characteristics, 4 topologies (quantitative analysis only), comparison of the input and output impedances of all the four topologies. Power amplifiers: concept of power amplifiers, class A class B and class AB, class C and class D power amplifiers, Distortion analysis. (Introductory level only)

FETs and MOSFETs: FETs: Theory and fundamentals, classification of FETs, JFET, MOSFET, DMOS, EMOS, CMOS, VMOS (introductory level only), FET (BFW10) data sheet, CMOS ICs, difference between CMOS and TTL ICs, biasing, FET characteristics, Channel length modulation, FET amplifier and analysis (Gain, Bandwidth, input and output impedances). IC Design & Fabrication: Introduction to different types of ICs and Packaging's, IC Design and Fabrication.

Operational Amplifiers: Basics: Ideal OPAMP, OPAMP characteristics, ideal and practical OPAMP, CMRR, slew rate, Virtual Ground, inverting and non inverting amplifiers, (3 hrs)

Applications of OPAMPs: Adders, subtractors, scaling amplifier (using LM324 - Quad OPAMP), Integrator, Differentiator, comparator using 710 IC, Schmitt trigger, Instrumentation amplifier. Active filters: design of LP, HP, BP, BS filters (Butterworth filter, first order and 2nd order).
Misc. Topics:
Oscillators: Function generator using LM1428, Barkhausen's criteria for sustained oscillations, Classification of oscillators, RCPS, WBO (using 741 OPAMP), Hartley and Colpitts oscillators (using transistors), crystal oscillator, 555 Timer, functional architecture of 555, Astable, monostable and bistable operation using 555. (6 hrs) Filters: Continued LC Filters, RC Filters, RLC Filters, ripple factor for Half Wave rectifier and Full wave Rectifier. Regulators: Concept of regulation, Design of voltage regulators using LM339, IC 723, 78XX and 79XX series, SCR, Triac.

Text Books

1 Electronic Devices and Circuit Theory 12th Edition - Robert L. Boylestad
2 Electronic Devices and Circuits 5th Edition – David A. Bell
3 Linear IC Applications - Ramakanth Gaykwad

Reference Books

1 Integrated Electronics by Millman & Halkias
2 Electronic Circuits by Schilling & Belove
3 Digital Integrated Electronics by Taub and Schilling

19EC2104 – COMMUNICATION SIGNALS & SYSTEM DESIGN

L-T-P-S : 3-1-0-0
Credits : 4
Contact Hours : 4
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Ability to represent Analog signal(s) as mathematical function(s) and Manipulate them into more desirable function(s) by using the several available mathematical operations. Understand the three types of system representation. Ability to compute the response of the system for any given input and impulse-response function.	**1,6**	**2**
CO2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	**1,3**	**2**
CO3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	**1,2,8**	**2**
CO4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain	**12/1**	**3**

Gist: (a) Basic: LTI, Convolution, correlation, Laplace T. (b) Fourier Transform, Hilbert Transform, (c) Sampling, Quantization and Reconstruction, Z-transform, (d) ARMA model, poles, zero's, DTFT.

Syllabus: Basics of Analog Signals and Systems: World view of signals, Classification of signals, Mathematical representation of classifications, Basic signals, Operations on signals, Build complex signals from basic signals, Correlation. Introduction to Systems concept, Properties of systems, LTI system, impulse response, convolution, Properties of LTI system.

Signal Transformations and Translations: Laplace Integral, LT of basic signals, Inverse Transfer function, Transfer function of LTI system, ROC. Fourier Integral, FT of basic signals, from F.S to F.T, Properties of FT, Frequency translation, Dirichlet conditions, Parseval's theorem, Frequency response. Power spectrum-Graph. Hilbert integral, applications. Weiner-Khinchin Theorem (optionally).

Analog to Discrete World: Basics of Sampling-Graphical, Nyquist-Shannon Theorem, Graphical proof for band limited signals, Band pass sampling, Reconstruction of signal from its samples,

effect of under sampling – Aliasing, Quantization and Quantization error. Cauchy Integral theorem (optionally), Z-Transform and its ROC, Inverse Z-Transform, Properties.
Systems Design and Analysis: ARMA model, Poles & Zeros, Stability. DTFT, Analysis and synthesis, Differences between FT, DTFT, DFT -Graphically. DTFT of standard sequences. DFT of standard sequences-Graph, magnitude and phase spectrum, Properties.

Text Books

1 Signals, Systems, and Transforms, Phillips, Parr and Riskin, Fourth Edition, Pearson Education, 2008.
2 Statistical Digital Signal Processing and Modelling, Monson H. Hayes, 2009.
3 Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.

Reference Books

1 Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
2 Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition
3 Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008

19EC2105 – ANALOG AND DIGITAL COMMUNICATION

L-T-P-S : 3-0-3-0
Credits : 4.5
Contact Hours : 6
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyse the linear and non linear modulation concepts	**1**	**3**
CO2	Explore the basic digital communication systems and principles	**1, 3**	**2**
CO3	Learning various line coding procedures and signalling schemes to facilitate data communications.	**1, 3**	**2**
CO4	Understand the concepts of multiple access and various types of networks.	**1, 3**	**2**
CO5	Analysis and design of Modulation and Demodulation features of various Analog & Digital Communication Systems.	**5**	**4**

Gist: (a) Modulation: AM, FM, PM – Types, Index, Noise (b) Digital Communications: sampling, aliasing, PCM, SNR, BW, DPCM, DM, ADM,, (c) Switching, signaling, Appn: ASK, FSK, PSK, QPSK, MSK, SS7, PSTN, DSL/ADSL, T1/E1, SDH, (d) Modern Communications: FDMA, TDMA, CDMA, LAN, WAN.

Syllabus:

Fundamentals of Analog and Digital Communications

Introduction Modulation types: AM, FM, Pulse Mod, SNR, Bandwidth, Beam width, Power Spectrum.

(a) AM Concept : DSB-SC, SSB, Coherent detection, Modulation Index.

(b) FM Concept: FM Clicks, Modulation Index, FM Clicks &Threshold and Phase Modulation

(c) Pulse Mod. Concept: PAM, PWM, PPM Modulation and Demodulation using IC

Formulae and Numericals; Transceiver, Noise and types of noise.

Digital Communication Basics: Sampling theorem and aliasing, PCM: Quantization noise, SQNR, Formulae and Numericals, SNR vs Bandwidth; DPCM, DM, ADM coders, Formulae and numericals, Vocoders: LPC, CELP, RPE-LTP, Switching.

Signaling and Digital Communication Applications

RZ, NRZ, Bipolar RZ AMI, Manchester, HDB3 and B8ZS and circuit implementations, Bits and Bauds, ASK, PSK, FSK, QPSK, QAM, MSK, bandwidth consideration, formulae and Numericals.

Telecomm Systems: circuit switching, T1/E1, SS7 signalling, PDH and SDH, DSL/ADSL,PSTN Switching.

Modern Communication Methods

Multiplexing and Multi access, FDMA, TDMA, CDMA, CSMA; OFDMA, Rake receiver, Spread spectrum Techniques.

Data Commm Systems: Packet Switching, PAN, LAN, WAN, MAN, Internetworking, VoIP.

Text Books

1. Simon Haykin and Michael Moher, "An Introduction to Analog and Digital Communications", 2nd Ed., Wiley, (2007).
2. Wayne Tomasi, Advanced Electronic Communication Systems", 6th Ed.,Pearson Education.
3. B. Forouzan," Data Communications and Networking", 4th Ed., Mc graw Hill.
4 W. Stallings," Data and Computer Communications",8thEd.,Pearson Education.
5 T. Rappaport," Wireless Communications Principles and Practice", 2nd Ed., Pearson Education (2009).

Reference Books

1 H Taub & Schilling, Gautam Sahe," Principles of Communication Systems", TMH, 3rd Edition, (2007).
2 R.P. Singh & S.D. Sapre," Communication Systems: Analog and Digital", Mc Graw Hill, 3 rd edition.

20EC2106 – EMBEDDED CONTROLLERS & EMBEDDED SYSTEM DESIGN

L-T-P-S : 3-0-2-2
Credits : 4.5
Contact Hours : 7
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the architecture and programming concepts of 8086 Microprocessor	**1,2**	**2**
CO2	Apply the Programming concepts of 8051 Microcontroller	**5**	**3**
CO3	Analyse the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers	**3**	**4,2**
CO4	Understand the basic concepts of CORTEX STM-32 microcontroller and RTOS	**2**	**2**
CO5	Analyze the applications of programming with 8051 and 8086 on hardware / software. Analyze the applications of programming with Arduino	**5**	**4**

Gist: (a) Basics: 8086 Architecture & Instruction set, (b) µC Fundamentals: 8051, (c) Peripherals, I/O, ARM7, (d) CORTEX (STM32) and RTOS, SoC

Syllabus:

Basics of Embedded System: Basics, Introduction and History of Processors, 8086 Architecture, Instruction set, 8086 programming and examples.

Microcontroller Fundamentals: 8051 Architecture, Addressing modes, Instruction set, Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Interrupts.

Serial Data Communication and RS-232C Standard with 8051 Programming, Peripherals and Input Output with 8051 Microcontroller (PIO, Timers and Interfacing).

Modern Microcontrollers: Introduction and Architecture of PIC Microcontroller, Introduction of ARM7 (LPC2148), Basic Architecture of ARM7, Pin Description, Advanced Microcontroller Bus Architecture (AMBA).

Advanced Topics: Introduction to CORTEX (STM 32), Architecture and Introduction to RTOS (Real Time operating systems). Basic concepts and applications of RTOS.

Text Books

1 Mazidi & McKinley "The 8051 Micro controller and Embedded systems: using assembles and C, 2nd edition, 2007.

2 Frank Vahid, "Embedded System Design", Wiley; Student edition (2006).

3 A K Ray and K M Bhurchandi "Advanced Microprocessors and Periperals " The McGraw Companies,2nd Edition,2006

Reference Books

1 Make: Arduino Bots and Gadgets: Six Embedded Projects with Open Source Hardware and Software by Tero Karvinen, Kimmo Karvinen

2 Practical Microcontroller Engineering with ARM Technology by Ying Bai

Web References

1 https://www.youtube.com/watch?v=DmwOSdwzZ3E

2 https://www.youtube.com/watch?v=GPz_mR7Flas

3 https://www.youtube.com/watch?v=fI20Bsx3EPM

4 https://www.youtube.com/watch?v=S2_KtA_6y80

19EC2207-ELECTROMAGNETIC FIELDS & APPLICATIONS

L-T-P-S : -1-0-0
Credits : 4
Contact Hours : 6
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of EM fields and magnetic fields	**1,2**	**2**
CO2	Study of wave propagation in wave guides, coaxial cables and other materials.	**1,2**	**2**
CO3	Analysis and study of application s of EM waves	**1,2**	**3**
CO4	Analysis and study of advanced topics in EM wave applications	**1,2**	**3**

Syllabus:

Basics of EM Theory

a) Introduction to Electromagnetic fields, significance, and possible range of applications.
b) Electromagnetic spectrum: various frequency bands
c) Electric fields: Charge distributions, Coulomb's Law, Electric field intensity, electric flux density, Gauss's Law, current densities, equation of continuity, Boundary conditions.
d) Magnetic fields: Biot-Savart's Law, Ampere's circuital law, Stoke's theorem, force on a current element in magnetic field**,** Boundary conditions.

EM waves and propagation

Faraday's laws, Maxwell's equations, EM fields, Wave propagation theory, Wave propagation in free-space, TE,TM, TEM waves, Energy, Guided-waves, Transmission lines,Wave guides, Co-axial cables, Electromagnetic Materials, Metamaterials.

Applications of EM waves Wireless, Wifi, Signaling in railways, Sensing techniques for studying biological cells, Microwave Oven, Microwave Imaging Methods, Telemetry, Medical Applications, Microwave Spectroscopy, Ion-Thruster for Space Applications, Agricultural Applications, Food Processing Applications.

Advanced topics on EM waves

Radars, Defense Applications&Stealth, Weather Applications& millimeter Radars, EMI/EMC, Nuclear magnetic resonance imaging(nMRI),Reflectivity &Shielding methods.

TEXT BOOKS:

1. W H.Hayt& J A Buck : "Engineering Electromagnetics" TATA McGraw-Hill, 8th Edition 2014
2. Mathew O Sadiku, "Elements of Electromagnetics ", Oxford University Press, 2015.

3. EC.Jordan, “EM waves and Radiating Systems”, International Edition, 2011.

REFERENCE BOOKS:

1. Constantine A. Balanis,” Advanced Engineering Electromagnetics” John Wiley.
2. John D Ryder , “Netwotk Lines and fields”, 2nd Edition, PHI.
3. Handbook of Electromagnetic Compatibility, ISBN: 978-0-12-550710-3
4. Skolnik, “Introduction to radar systems”.

19EC2208 – DIGITAL SIGNAL PROCESSING

L-T-P-S : -3-0-2-0
Credits : 4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Analysis of FFT & Wavelets	**1,2**	**2**
CO2	Explore and Design the Digital filters: Digital FIR	**2**	**3**
CO3	Analysis and Design the Digital filters: Digital IIR	**2**	**3**
CO4	Understand and apply multi-rate signal processing, interpolation and decimation concepts	**3**	**2**
CO5	Design and Analysis of LTI Systems and Filters	**3**	**4**

Syllabus

FREQUENCY TRANSFORMATIONS

Introduction to DTFT and DFT (Realization using MATLAB) – Properties of DFT – Circular Convolution– FFT Algorithms: Decimation – in – time Algorithms, Decimation – in – frequency Algorithms, concept of Z Transform for system function (Realization using MATLAB Realization using MATLAB), Review of D.T Sequences & systems

IIR FILTER DESIGN

Block Diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems: lattice and lattice-ladder structures, Transposed forms. Concepts of Butterworth analog Low pass filter design – Discrete time IIR filter from analog filter Realization using MATLAB Realization using MATLAB) – IIR filter design by Impulse Invarianc Realization using MATLAB Realization using MATLAB) e, Bilinear transformation, Approximation of derivatives – (LPF, HPF) filter design using frequency translation.

FIR FILTER DESIGN

Direct and cascade form Structures for FIR Systems, Linear phase FIR structure - FIR filter design Realization using MATLAB Realization using MATLAB): using Fourier Series method, using windowing techniques (Rectangular Window, Hamming Window, Hanning Window).

ADVANCED SIGNAL PROCESSING CONCEPTS:

Decimation, Interpolation, Sampling rate conversion by rational factor Realization using MATLAB Realization using MATLAB), Design of perfectly reconstruction Filter banks- Design of delay line - Filter banks and Wavelets-Their applications for analysis of non stationary signals, speech signal compression, de-noising. Realization using MATLAB Realization using MATLAB)

Text Books

1 John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education, Prentice Hall, 2007.

2 Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Third Edition, Tata Mc Graw Hill, 2007.
Ali Ankasu, Simtha nd Kaiser "Subband and Wavelet transform: Designa and applications" Kluwer house, 1998.

3 M.Vettorli, Kovacevic, "Suband coding and wavelets," Prentice hall, 2007.

Reference Books

1. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, 2004.
2. G.J.Miao,l "Signal Processing for Digital Communications " Artech House.
3. C.S.Burrus, R.A.Gopinath, H.Guo, "Introduction to Wavelets and Wavelet Transforms," Prentice hall,2003.
4. Vinay K. Ingle, John G. Proakis," Digital Signal Processing Using MATLAB AND wavelets," PWS publishing, 2007.

20EC2209A-STATISTICS, AI, ANN

L-T-P-S : -3-0-2-0
Credits :3.5
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the conditional probability and discrete distributions to suitable real- world situations.	**1,2**	**3**
CO2	Apply queuing models for single and multi-server s with finite and infinite queue capacity to suitable real world problems.	**1,2**	**3**
CO3	Study of introduction and search methods	**2,3**	**2**
CO4	Study the basics of ANN, FFN and FBNN	**1,3**	**2**

Syllabus

Random Processes and Random Variables
Probability - Coin experiment, Ball experiment, Card experiment, Dice Experiment, Sequence of Coin tossing, Combination, Permutation, Probability Density function, expectations, mean, variance, Random Processes and random variables.
Stochastic Processes
Coin tossing, 2 Coin tossing, 3 Coin tossing, Biased coin tossing, Baye's theorem. Hidden Markov Model, Trellis Algorithm, Viterbi Algorithm. Introduction to Artificial Neural Networks. Cumulative Frequency -less than type-Ogive, Cumulative Frequency- more than type -Ogive.
Introduction to Artificial Intelligence
Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI, Agents. **State Space Search**: Depth First Search, Breadth First Search, DFID
Heuristic Search: Best First Search, Hill Climbing, Python Programming implementation with Artificial Intelligence.
Basics of ANN, FFN, FBNN:
Overview of Artificial Neural Networks, Different Learning Methods and Architectures, Activation functions and its classification, Perceptron, Multi-Layer Perceptron, Hinton's Model, Feedforward Neural networks, Feed-Back Neural-networks**.** Introduction to CNN, RNN and DNN.

Text Books

[1]. Communication Systems by Simon Haykin
[2]. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning,

Morgan Kaufmann, 2004.

Reference Books

[3]. R.O.Duda, P .E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.
[4]. Artificial Neural Networks by Prof. B. Yegnanarayana.
[5]. Simon Haykin, Neural networks and learning machines, Pearson Education, 2016
[6]. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003

20EC2209-AI & ANN TOOLS AND APPLICATIONS

L-T-P-S : -3-0-0-0
Credits :3
Contact Hours : 5
Pre-requisite : NIL

CO. No	Course Outcome	Mapped PO	BTL
CO1	Understand the basics of Probability, statistics and its Applications.	1,2	1,2
CO2	To understand the applications and tools of AI	1,2	2,3
CO3	To understand the concepts of AI searching techniques and ANN models	1,2	2,3
CO4	To Implement AI and ANN Models for real time problems	1,2	1,2

Syllabus:

Random Processes and Random Variables
-Probability: Coin experiment, Ball experiment, Card experiment, Dice Experiment;
-Combination, Permutation, Random Processes and random variables;
-Introduction to Sequence of Coin tossing: Joint probability examples and Hidden Markov Model

Applications of AI &Tools
-Introduction to MATLAB, Python, R tools for Statistical analysis;
-AI Virtual Agents, AI Chatbots, AI for Personalized Shopping Experience;
-Artificial Intelligence in Agriculture;
- Introduction to 3rd party AI tools

Basics of AI &ANN
-Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI.
-State Space Search: Depth First Search, Breadth First Search,DFID
-Overview of Artificial Neural Networks, Different Learning Methods and Architectures.
-Supervised and Un-supervised learning concepts: Activation functions and its classification, Perceptron;
Neural Network Classifiers: Multi-Layer Feedforward Neural networks, Multi-Layer Feedback Neural Networks.

AI, ANN Models, Implementation and Case Studies
-Implementation of AI: Programming implementation with Artificial Intelligence;
-Implementation of Search techniques for pattern recognition;Hill Climbing, Travelling salesman problem;
-Implementation of 2-class pattern recognition;
-Image recognition using Feedback Neural networks;
-Introduction to CNN

Text Books

[1]. Probability, Random Variables and Random Signal Principles By Peyton Peebles., Tata Mc Graw-hill

[2]. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, Elsevier Science & Technology, 2011.

References

[3]. R.O.Duda, P .E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.

[4]. Artificial Neural Networks by Prof. B. Yegnanarayana.PHI

[5]. Artificial Neural Networks by Simon Haykins

[6]. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003

19EC2210-DATA NETWORKS & PROTOCOLS

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the fundamentals of networking and protocols	**1**	**2**
CO2	Understand the networking technologies	**1**	**2**
CO3	Understand the Access networks	**2**	**2**
CO4	Understand the concepts of modern networking	**2**	**2**
CO5	Analysis and study of concepts of networking.	**5**	**3**

Syllabus:

Introduction to Computer networks and Data Link Layer:
Introduction to Computer networks Use of Computer Networks, Network Hardware, Network software, Reference models: OSI and TCP/IP, Example Networks, Physical Layer: The theoretical basis for Data Communication, Guided and Unguided Transmission Media, Switching, Modems, ADSL, Trunks AND Multiplexing.
Data Link Layer: DLL design issues. Error Detection and Correction, Elementary data link protocols, sliding window protocols. Medium Access Control Sub layer: Channel allocation problem, multiple access protocols, Ethernet.
Network layer and Internetworking
Internetworking Devices: Preamble to Network Layer**,** Distinguishing of Networking Devices and **Internetworking Devices**, Analysis of Router Processing: Access, core and distribution. VLANS, Ethernet
Internetworking Technologies: Wired Router, Wireless Router, Gateway, CSU/DSU; Addressing: IP addressing (IPV4 & IPV6), subnetting; Types of Routing: static, default and dynamic.
Networking Protocols: RIP, OSPF, BGP; Access Control list for IPV4, IPV6, Other Protocols: NAT, ARP, Port Address Translation (PAT), IP Tunneling; DHCP
Transport layer, Session Layer, Presentation Layer and Application Layer:
Transport Layer: Process to Process Delivery; UDP; TCP; FCP Fiber Channel Protocol; Stream Control Transmission Protocol (SCTP); Congestion Control: Open Loop, Closed Loop Choke Packets; Quality of Service: Techniques to Improve QoS: Leaky bucket algorithm, Token bucket algorithm.
Session Layer: ISNS Internet Storage Name Service.
Presentation Layer: SSL , preface of Socket , Secure Socket Layer
Application Layer: Telnet, TFTP, POP3, DNS, SMTP, SNMP, FTP, NTP, SSDP.
Advanced Topics:
Cryptography: Public and Private Key based) Digital Signature , Firewalls

Advancements in Application layer: ISDN services & ATM, DSL technology, wired and wireless Modem: Architecture & Operation in brief.
Wireless LANs: IEEE 802.11; Multi-Band Routers (Tri Band Wireless Routers);
Network Security: Essential Steps for Configuring a New Server and firewalls, Different types of network layer attacks and IP security.

Text Books

1 Data Communications and Networking (3rd Ed.) "–B. A. Ferouzan – TMH
2 Computer Networks (4th Ed.)", A. S. Tanenbaum – – Pearson Education/PHI

Reference Text books

1 Data and Computer Communications (5th Ed.)" – W. Stallings – PHI/ Pearson Education
2 Network for Computer Scientists & Engineers, Zheng & Akhtar, OUP
3 Data & Computer Communication, Black, PHI
4 Data Communication & Network, Miller, Vikas
5 Digital & Data Communication, Miller, Jaico
6 Understanding Data Communication & Network, Shay Vikas

FLEXI CORE COURSES

19EC3015 – VLSI DESIGN

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the MOS device fabrication process	**2,3**	**2**
CO2	Analysis of MOS operation principles, characteristics and scaling process	**2,3**	**3**
CO3	Constructing the Transistor Level Logic circuits and understand the MOS layout design rules	**2,3**	**3**
CO4	Study of MOS circuit performance and testing principles	**3,4**	**3**
CO5	Create the MOS circuit modules through project-oriented approach using e-CAD tools	**5**	**4**

Syllabus:

Basics of VLSI Design & IC Technology: MOS transistor analysis, Transistors Fabrication steps – PMOS, NMOS, CMOS & Bi-CMOS. Current-voltage characteristics of MOSFETS, MOS drain current equation and regions of operation, threshold voltage and body effect, second order effects.

NMOS and CMOS Inverters: MOS Inverters: Resistive load, depletion load, enhancement load, CMOS inverter, Static and Dynamic characteristics, Inverter Delay, Dynamic & Static Power Dissipation. W/L ratio for NMOS and CMOS inverters, noise margin, NMOS and CMOS Voltage transfer Characteristics, Latch up in CMOS Circuits. Scaling of MOS Circuits.

VLSI Circuits and Design Methods: NMOS, CMOS and Bi-CMOS Inverter design and analysis. NMOS, CMOS, Pass Transistor and Transmission Gate based logics, Stick Diagrams and layouts for digital Logics, Design rules: lambda-based design rules.

Design for Testability: Sheet Resistance RS, Area Capacitance and Delay calculations. CMOS Fault models, Testing of Combinational logics, testing of sequential logics, Scan design techniques, Built-In-Self-Test (BIST).

Text Books

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Ed., 2011

2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Ed., 2011

3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Tata Mc-Graw-Hill, 3rd Ed., 2003

Reference Books

1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Ed., 2012

2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Ed., 2009

19EC3016 – WIRELESS COMMUNICATIONS

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts of wireless communications & various Technologies	**1,2**	**2**
CO2	Understand the basic concepts of mobile radio propagation	**2,3**	**2**
CO3	Understand the basic concepts of equalization and diversity techniques	**2,3**	**2**
CO4	Understand and applications of concepts of multiple access techniques	**3,4**	**3**
CO5	Analysis and design of electronic circuits for modern communication standards	**3,4**	**4**

Syllabus

Introduction to Wireless Communications: Examples of Wireless Communication Systems, Cellular telephone Systems, 2G & 3G wireless networks, Cellular concept, frequency reuse, Channel Assignment strategies, Hand off strategies, Interference and system capacity, improving coverage and capacity in cellular systems.

Mobile Radio Propagation: Large Scale Fading, Free space propagation model, Three basic propagation mechanisms: Reflection, diffraction, scattering, Small Scale Fading, Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, fading effects due to multipath delay Spread and Doppler spread, Rayleigh and Ricean distribution models. Statistical models for multipath fading channels.

Equalization and Diversity Techniques: Equalization, Fundamentals of Equalizers, Linear equalizers, nonlinear equalizers, Decision feedback equalizers, MLSE, Algorithms for adaptive equalization, Space diversity, MRC, EGC, selection diversity, Polarization diversity, Frequency diversity, Time diversity, Rake receiver. Multiple Access Techniques – TDMA, FDMA, CDMA.

Wireless Systems and Standards: GSM Services Features, Architecture, Channel types. Frame Structure, CDMA (IS95), PACS, Personal Communication Satellite Systems (PCSS), IEEE 802.11A, UMTS and 4G Technologies – OFDM for wireless communications.

Text Books

1 "Wireless Communications Principles and Practice", Theodore S. Rappaport, 2nd Edition, Pearson Education, 2003.

2 "MIMO Wireless Communications", Ezio Biglieri, Andrea Goldsmith, Arogyaswami Paulraj, Cambridge University press, 2007.

Reference Text books

3 "New directions in wireless communication research", V. Tarokh, Springer,2009

4 "Orthogonal Frequency Division Multiplexing for Wireless Communications", Ye (Geoffrey) Li, Gordon Stuber Springer, 2006.

19EC3017 – RF SYSTEM DESIGN

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Importance of RF Circuit Design, RF behaviour of passive components, Compare Types of Transmission Lines and represent Equivalent Circuits	**1,2**	**2**
CO2	Understand and analyse he RF diode, BJT and FET characteristics, and modelling amplifier input and output impedance matching with Graphical AID/Tool for RF Design;	**2,3**	**2**
CO3	Analyze Stability Considerations and stabilization methods to design RF Amplifiers Using Small Signal Analysis	**2,3**	**3**
CO4	Analyze high frequency oscillator configuration and mixer designs.	**3,4**	**3**
CO5	Analysis and design of RF electronic circuits	**3,4**	**4**

Syllabus

Introduction to RF System Design*:* Importance of RF and Microwave Circuit Design-Dimensions and Units- Frequency Spectrum - RF Behavior of Passive Components: High Frequency Resistors, Capacitors, Inductors, The Smith Chart: Introduction, Applications of Smith chart: Impedance measurement for single and double stub.

Design considerations of RF Filters: RF Filter Design: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modeling, Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations.

Design Considerations of RF Amplifiers and Oscillators: Characteristics of amplifier-amplifier power relations-stability consideration-constant gain-broadband, high power, and multistage amplifiers, Small signal analysis of amplifiers. Basic oscillator model-high frequency oscillator configuration.

Other Design Considerations and Real-Time Applications:

Design considerations of RF Receiver, Mixer in communication receiver, Optimization techniques. Applications: Wireless Transceiver design.

Text Books

1 Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics”, Pearson Education Asia, Second Edition

2 Reinhold Ludwig and Powel Bretchko, “RF Circuit Design – Theory and Applications”, Pearson Education Asia, First Edition.

Reference Books

1 Joseph . J. Carr, “Secrets of RF Circuit Design”, McGraw Hill Publishers, Third Edition.

2 Ulrich L. Rohde and David P. New Kirk, “RF / Microwave Circuit Design”, John Wiley & Sons.

3. Roland E. Best, “Phase - Locked Loops: Design, simulation and applications”, McGraw Hill Publishers 5th edition.

4. Devendra K.Misra , “Radio Frequency and Microwave Communication Circuits – Analysis and Design”, John Wiley & Sons, Inc.

19EC3018 – BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of measuring instruments, transducers, and bio-electric amplifiers/recorders	**1,2**	**2**
CO2	Study of various bio-signals	**2,3**	**2**
CO3	Understand and analysis of various modern bio-medical instruments	**2,3**	**2**
CO4	Study of modern IoT application for health care	**3,4**	**2**
CO5	Design and development of IoT applications for health care	**3,4**	**4**

Syllabus

Bio potential recordings and measurements: The origin of Bio-potentials, bio-potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, lead systems and recording methods, typical waveforms and signal characteristics, Non electric parameter measurements, pH, PO2, PCO2, colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood Cell Counters.
Medical Instrumentations: Cardiac pacemakers, DC Defibrillator, Dialyser, Heart lung machine, Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy Telemetry principles, frequency selection, biotelemetry, radio-pill, electrical safety, Recent Trends in Medical Instrumentations, Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine

IOT for Healthcare: Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device, Industrial/Healthcare sensors – Description & Characteristics–First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors' Swarm – Description & Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap

Application of IOT In Healthcare: smart-wearables, smart-clothing, elderly fall-detection, infant care system, Monitor an aging family member, Scalable, continuous, heart rate monitoring

Text Books

1 Hemalatha Rengasmy & Jeganathan, "Biomedical Techniques and IoT Applications in Health Care", LAP LAMBERT Academic Publishing, 2019.

Web References

1 https://www.udemy.com/course/iot-based-emergency-health-care-system/
2 https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106105195/lec51.pdf
3 https://www.youtube.com/watch?v=O0CHWFc-gO8
4 https://www.youtube.com/watch?v=thCFMeB8pHM&list=PLKcjQ_UFkrd7zbPHRkDpB7i113wDG_Rb3
5 https://www.youtube.com/watch?v=dSRWgyXzZeA
6 https://www.youtube.com/watch?v=8qqWwLc4e44

19EC3019 – ELECTRONICS INSTRUMENTS & AUTOMATION

L-T-P-S : 3-0-2-0
Credits :4
Contact Hours :5
Pre-requisite : NIL

19EC3020 – SYSTEM ENGINEERING, OPERATION RESEARCH & DESIGNING

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction to the concepts and techniques of system design	**1,2**	**2**
CO2	Understand the basic of operation research	**2,3**	**2**
CO3	Understand and application of design objectives, industry & market forces and product design strategies	**2,3**	**3**
CO4	Understand and analyze the product design goals, methodologies.	**3,4**	**3**

Syllabus:

Introduction to system Design[: Systems Engineering – Basic Definitions - System Life cycles -Phases-Steps, Formulation of Issues: Problem Identification – Scoping – Bounding, Problem definition – Identification of needs, alterable, constraints; Value System Design: Objectives and objective measures; Functional decomposition and analysis Tools: Objectives hierarchies – trees, cross interaction matrix; Functional analysis approaches – Node tree, Context diagram, system decomposition;

Decision Making :

Types of decisions – descriptive, prescriptive, normative; Decision assessment efforts types – under certainty, probabilistic uncertainty

Basics of Operation Research[4-6]: Introduction to Operation Research; operations Research Models; Characteristics of operations research; Structure of the Mathematical Model, Limitations of Operations Research ; Solving the OR Model; Queuing and Simulation Models, objective of operations research; Introduction to Foundation mathematics and statistics Linear Programming (LP), LP and allocation of resources, LP definition, Linearity requirement; Objective Functions; Costs; Constraints;

Finite Queuing Models[4-6]: Introduction, Finite Queuing Models; Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT; Game Theory: Introduction, Competitive Situations, Characteristics of Competitive Games, Maximin – Minimax Principle, Dominance; Models and Modeling in Operations Research, Advantages and Applications of Optimization Models.

Design objectives[4-6]: introduction to Design Objectives(DO); types of Design Objectives, operation of product & Services, user interfaces, visual& sensory,, technology, environment, design considerations, lightness, design constraints, design to cost, Design-to-value vs Design to Cost; design to value;

Strategic Research Agenda (SRA)[4-6]in Industry, Market forces SRA, Product design strategies: survey, envision, develop, deliver; PDS tactics Discover, Design, Build, And Launch, ATP (Available to Promise) ATP

User Interface (UI), User Experience (UE) & Product Design[4-6]: Definition, principles and practice of User Interface (UI) / User Experience (UX); Elements of User Experience Design. Designing parameters of User Experience (UX), lifecycle of design—the process, purpose, and tools, architectural operations on (UX), human centered design, product design, UI/UX design, Usability Test process of UI & UX,

Product Designer (PD)[4-6]: Evolution of UI/UX Designers into Product Designers, product design and development of UI and UX. Design Thinking of product interfaces and user interface, integration of small, medium, large scale UI & UX project development training module. Web design-based UI

Text Books

1. Andrew P Sage and James E Armstrong, Systems Engineering, Wiley Inter science publications (2004)
2. Alexander Kossiakoff, William N. Sweet, Systems Engineering : Theory & Practice, John Wiley & Sons, 2002
3. James N. Martin, Systems Engineering Guidebook: A Process for Developing Systems and Products, CRC Press, 1997
4. UI UX Design Hardcover – Illustrated, 25 Dec 2016 by Xia Jiajia

Web References

1. Handbooks in Operations Research and Management Science
2. Web UI Design Patterns 2016 Volume 2: Layouts, Content, Data, Scrolling, Multimedia

19EC3021 – ELECTRICAL TECHNOLOGIES & SOLAR POWER SYSTEMS

L-T-P-S : -3-0-2-0
Credits :4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of electrical technology	**1,2**	**2**
CO2	Study and understand of power generation, transmission and distribution.	**2,3**	**2**
CO3	Study of electrical grids, smart grids, IoT applications in smart grids and remote management	**2,3**	**2**
CO4	Analysis and study of solar photo voltaic cells, AI & ML in solar cells array and networks	**3,4**	**2**
CO5	Design and analysis of photo voltaic cells for power generation and implementation of AI & ML for the analysis of solar cell arrays.	**3,4**	**3**

Syllabus:

Basics of Electrical Technologies: Elementary concepts of electric circuits, Kirchhoff's laws, constant voltage and current sources, Electromagnetic induction, DC Machine, DC Generators, DC Motors, Three phase systems, star and delta connection. Transformers and bus bars.
Power Generation and Distribution: Elements of the power grid and measurement technologies: generation, transmission, distribution, and end-user; Basic concepts of power, load models, load flow analysis and losses. Distribution system monitoring and control: SCADA, Concept of modern distribution systems.
Electrical Grids and Smart Grids: Evolution of Electric Grid - Definitions, Architecture, Functions and control layer and elements of Smart Grid. Energy management system (EMS), Wide area monitoring system (WAMS) and phasor measurement units (PMU); Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering.
Solar Photovoltaic systems: Photovoltaic Cells: Operation, performance testing of cells and efficiency - PV modules, panels, string, arrays, sub array and blocking diodes. Solar Photovoltaic Systems: Configuration, Types of system stand alone and grid connected system. Solar PV system design: design consideration, process and design aid expert with AI and ML

Text Books

1. Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson
2. D P Kothari and I Nagrath, "Power System Engineering," 2/e Tata McGraw Hills,

2008

3. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-470-62761-7, Wiley
4 Konrad Mertens, Photovoltaics: fundamentals, technology and practice Chichester, West Sussex, United Kingdom: John Wiley & Sons Inc., 2014.

Reference Books

1. Mehta V K and Mehta Rohit, Basic Electrical Engineering, S Chand & Company, 2006
2. Modern Power system Analysis: D P Kothari and I J Nagrath, Tata McGraw Hill
3. James Momoh, "Smart Grid Fundamentals of Design and Analysis," Wiley, 2012
4. Kaushika, N.D, Solar Photovoltaics Technology, System Design, Reliability and Viability, Springer, 2018
5. Janaka Ekanayake Smart grid Technology and application Wiley

19EC3022 – Advance Course in Soft-Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)

L-T-P-S : 3-0-2-0
Credits ::4
Contact Hours : 5
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of basic search algorithms	**1,2**	**1**
CO2	Study and applications of ANN and deep learning	**2,3**	**2**
CO3	Application of various ML techniques of kMeans, kNN, SVM and GMM	**2,3**	**3**
CO4	Understand of various advance computing methods	**3,4**	**2**

Syllabus:

Advanced topics in AI:
BFS, DFS Search Techs
(ii) Bayes Rule, Logic Progg, Knowledge Systems: Naive Bayes, Linear Regression, Logistic Regression, Objectives of KBS, Components, Categories, Knowledge Based System Architecture
Advanced topics in ANN:
Non linear classification, Gradient Descent algorithm, Boltzmann Machine,
Recurrent Neural Networks, Associative memories, Hopfield networks Convolutional Neural Networks
Deep Learning, Deep Neural NWs:
Few Topics in ML:
Curse of dimensionality, PCA, Linear Discrimant Analysis, extensions of LDA, clustering, k-Means algorithm, Expectation Maximization algorithm Method, Vector quantitiztion, suppot vector machine, variations in SVM, Gaussian Mixture models, applications of GMMs.
Intro Other Computing Methods:
Adaptive Fuzzy Logic: Fuzzy logic and fuzzy sets: Membership functions, operations on fuzzy sets, types of fuzzy functions, Fuzzy relationships;
Genetic Algorithms: Basic Operations of a Genetic algorithm, Genetic cycles

Text Books

1 Neural Networks and learning machines, Simon Haykin, 3e, 2016.
2 MacKay, David. *Information Theory, Inference, and Learning Algorithms*. Edition;Version 7.2 (fourth printing)Cambridge, UK: Cambridge University Press, 2003.

Web References

1 https://www.coursera.org/specializations/machine-learning
2 https://www.coursera.org/learn/machine-learning
3 https://in.udacity.com/course/machine-learning-engineer-nanodegree--nd009t
4 https://www.udemy.com/machinelearning/

PROFESSIONAL ELECTIVE COURSES

RENEWABLE ENERGY & SMART CITIES

20EC3051 –WIRELESS SENSOR NETWORKS & IOT APPLICATIONS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of wireless sensor network technologies.	**3**	**2**
CO2	Study of BLE protocols in WSN security and power applications.	**3**	**2**
CO3	Study and application of IOT and WSN for smart cities/ villages.	**3**	**2**
CO4	Study of various IoT application in various domains	**3,5**	**2**

Syllabus:

Basics of Wireless Sensor Networks: Introduction to WSN, Basic Overview of Wireless Technology, Basic Sensor Network Architectural Elements, Challenges, Applications of WSN. Some Examples of Sensor Nodes, Sensor Network Scenarios, Optimization Goals and Figures of Merit. Gateway and Router Concepts. Network Topologies: Single Hop Star, Multi Hop Mesh and Grid, Two-Tier Hierarchical Cluster.
WSN, Bluetooth & Other Protocols and Standards: Classifications of MAC Protocols for WSN, Sensor-MAC Case Study. Routing Protocols and Strategies in WSN, WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation (Optional). ZigBee/IEEE802.15.4, IEEE 802.11/a/b/g, IEEE 802.16, Bluetooth, BLE, Infrared, Differences in range, Security, Power. Bluetooth, BLE and 6LoWPAN.
IoT & Smart Cities: IoT Applications in Smart Cities, WSN for Smart Cities, WSN Design Issues for Smart Cities, Performance Metrics. Garbage Disposal, Vehicle Management, Smart Home, Smart Grid, Smart-Village. IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View
IoT Applications: Healthcare, Wearables Dairy, Agriculture, Traffic Monitoring & Control, Pollution Management, Inter-Vehicular Communication, Vehicle Tracking, Finance Transaction. Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations

Text Books

1 Kazem, Sohraby, Daniel Minoli, Taieb Zanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007

2 Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network",

John Wiley and Sons, 2005

3 Arshadeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-on Approach", Universities Press Pvt. Ltd., 2015.

Web References

1 https://www.betteru.in/course/wireless-sensor-networks-online-course-certificate/

2 https://www.udemy.com/course/complete-guide-to-build-iot-things-from-scratch-to-market/

3 https://www.youtube.com/watch?v=7h5Wwk_mheg

4 https://www.youtube.com/watch?v=-oWlS66__Qo

5 https://www.youtube.com/watch?v=m45SshJqOP4

6 https://www.youtube.com/watch?v=D3yrk4TaIQQ

20EC3052 – SOLAR PHOTO-VOLTAIC CELLS & SOLAR POWER ARRAYS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of solar photo-voltaic cell structure	**3**	**1**
CO2	Study of basic physics and components of solar photo voltaic cells	**3**	**1**
CO3	Study and design of solar PV systems and testing	**3**	**3**
CO4	Analysis and design of SPV arrays	**3,5**	**3**

Syllabus:

Solar Photovoltaic Fundamentals and Characteristics: Structure, operations and characteristics of photodiode and solar cells. Photovoltaic Cells: Basic structure, materials and equivalent circuits. PV output Characteristics, performance testing of cells and efficiency. Introduction to PV modules, panels, string, arrays, sub array and blocking diodes.
Solar Photovoltaic Materials and SPV cell Production: Crystalline and amorphous silicon solar cells: Properties, production process, cells and modules, thin film solar cells, III-V solar cells, CdTe, CIGS, DSSCs, organic, hybrid and perovskite solar cells. Different techniques of solar cell fabrication and assemble: multi junction, stack (hybrid and HIT), concentrated solar cells and arrays.
Solar Photovoltaic Systems Design, Testing and Optimisation: Solar PV system design: design consideration, process and design aid expert. Performance test procedure for panels: Performance measurements, module reliability, stability and qualification testing. Voltage regulation: Grid connected structure, affine parameterization, sizing systems, feed forward control and PID controllers.
Solar Photovoltaic Arrays, Configurations and Applications: PV modules and arrays: module configuration, array topology optimization and fixed array topology. Based on SPV Application design and system reliability improvements: failure modes and effect analysis, fault tree models. Artificial Intelligence, Artificial Neural Networks and Machine Learning application for SPV systems in design reliability analysis, fault detection and fault tolerant systems.

Text Books

1. Jenny Nelson, The Physics of Solar Cells, Imperial College Press (2003)
2. Solar Photovoltaic's: Fundamentals, Technologies and Applications, C. S. Solanki, 2ndEdition, Prentice Hall of India, 2011

3. A. Freundlich, P. Verlinden, Wvan Sark, Photovoltaic Solar Energy: From Fundamentals to Applications, John Wiley & Sons Ltd. 2017.
4 Konrad Mertens, Photovoltaics: fundamentals, technology and practice Chichester, West Sussex, United Kingdom: John Wiley & Sons Inc., 2014.

Reference Books

1. Kaushika, N.D, Solar Photovoltaics Technology, System Design, Reliability and Viability, Springer, 2018
2. Reccab Manyala, Solar Collectors and Panels, Theory and Applications, Intech open, 2010
3. A. K. Mukerjee, nivedita thakur, Photovoltaic Systems: Analysis and Design, PHI Learning Pvt. Ltd., 2011
4. John Wiley & Sons, Inc, Crystalline Silicon Solar Cells, Goetzberger-Knobloch-Voss, 1998: Crystalline Silicon Solar Cells, 1998
5. Angèle Reinders, Photovoltaic Solar Energy: From Fundamentals to Applications, John Wiley & Sons, 2017
6. Weidong Xiao, "Photovoltaic Power System: Modeling, Design, and Control", Wiley, 2017

Web References

1 https://www.pveducation.org/
2 http://www.alternative-energy-tutorials.com/solar-power/photovoltaics.html
3 https://www.nrel.gov/research/re-solar.html
4 http://www.fsec.ucf.edu/en/consumer/solar_electricity/index.htm
5 https://nptel.ac.in/courses/115107116/
6 https://www.open.edu/openlearn/nature-environment/environmental-studies/energy-resources- solar-energy/
7 https://www.coursera.org/learn/photovoltaic-solar-energy/

20EC3053 – ELECTRONIC SYSTEMS FOR RENEWABLE ENERGY & SMART GRID

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of renewable energy electronics	**3**	**1**
CO2	Study and analysis of electronics systems for renewable energy sources	**3**	**2**
CO3	Analysis and study of smart grid sub-systems and circuits	**3**	**3**
CO4	Analysis of electrical smart grids	**3,5**	**3**

Syllabus:

Introduction to Renewable Energy Sources: Introduction to Renewable Energy, Types of Renewable Energy, Solar power, solar resource, hybrid systems, wind resource and wind firm, Electronic Power Converters in Wind Turbines and Solar Photo voltaic Systems.

Electronics Systems for Renewable Energy Sources: Grid Monitoring and state estimation: Introduction, method of state estimation, algorithms for state system, sensors for grid monitoring: feeder sensors for SCADA, distributed energy resource sensors, metering sensors, portable and temporary sensors, Managing Data: meter data management, smart metering rollout, delivering bill-ready meter data.

Smart Grid Sub-systems and Circuits: Asset management and conditioning monitoring, smart grids and condition monitoring, Reliability indices: Introduction to distribution system reliability, reliability assessment with distribution automation: Fault indicator DA scheme, DA scheme using sequential coordinated re-closers, automated smart load restoration DA scheme.

Electrical Smart Grids: Smart customer and smart Home, From Smart Grid to Smart cities to IOT: opportunity, looking to future. Enhancing smart grid stability with the implementation of heuristic algorithms. Advanced metering infrastructure, Smart grid cyber security, Smart grid communications, Restructuring of power systems.

Text Books

1 Vaughn Nelson, "Introduction to Renewable Energy" CRC Press, 1st edition, 2011.

2 Ahmad Hemami, "Electricity and electronics for renewable energy technology: an introduction",Taylor & Francis,2016

Web References

1 https://nptel.ac.in/courses/117108141/

2 https://onlinecourses-archive.nptel.ac.in/noc18_ee42/preview

3 https://www.youtube.com/watch?v=2XWIiS6M_-g

4	https://www.youtube.com/watch?v=AbNXbLm4iUs
5	https://www.youtube.com/watch?v=JwRTpWZReJk
6	https://www.youtube.com/watch?v=Ft8nAo5hzdQ

20EC3054 – IOT APPLICATIONS FOR SMART CITIES

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of smart cities/villages/living	**3**	**2**
CO2	Study of systems for smart cities with case studies.	**3**	**2**
CO3	Analysis and design of smart grid sub-systems and circuits	**3**	**4**
CO4	Study of advanced topics related to privacy, scaling and design considerations.	**3,5**	**2**

Syllabus:

Introduction to Smart Cities, Smart Villages and Smart Living:

- Characteristics of Smart Cities- Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, Smart Living.

- Introduction to IoT and Architecture, Introduction to IoT for Smart Cities.

- IoT based solutions for Smart Cities – Smart Grid, Smart Home, Transport and Traffic Management, Smart Healthcare.

- Challenges- Planning, Cost and Quality, Security and Privacy, Risks,

- IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Systems for Smart Cities:

- World's Examples- International and National Case Studies.

- Network Infrastructure for Smart Cities, Emerging Technologies, Challenges and Concerns.

- Systems for Smart Cities: Smart Grid, Smart Vehicle Tracking, Security, Traffic, Pollution, Smart Home, Advanced Safety & Security Systems, Smart Water Management, Smart Waste Management, Smart Buildings, Smart Mobility, Smart Economy, Smart Environment, Smart Energy and Healthcare.

- IoT Systems Design Methodology for Smart Cities Applications.

- ICT for Smart Cities - ICT Architecture, Major Technology Areas, ICT Systems for Smart Cities.

Designing IoT Systems for Smart Cities:

- Designing Systems for: Home Automation, Street Lighting, Advanced Safety & Security Systems, Garbage Disposal, Vehicle Management, Smart Home, Smart Money.

- IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT.

- Miscellaneous Topics: Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry.

Design Considerations, Economics and Issues in IoT Applications:

- IP Protection, Security, Privacy and Scaling issues in IoT for Smart Cities.
- Trust in IoT-Data-Platforms for Smart Cities.
- First Steps Towards a Secure Platform, Data Aggregation for the IoT in Smart Cities.
- Design Considerations, Economics.
- Introduction to M2M to IoT, M2M Value Chains, IoT Value Chains, M2M to IoT-An Architectural Overview.

Text Books

1 Ejaz, Waleed, and Alagan Anpalagan. Internet of Things for Smart Cities: Technologies, Big Data and Security. Springer International Publishing, 2019.

2 P P Anil Kumar, Introduction to Smart Cities, Pearson India; First edition, 2019.

3 Michael Miller, "The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", Pearson Education, 2015.

REFERENCE BOOKS:

1 Arshadeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-on Approach", Universities Press Pvt. Ltd., 2015.

2 Stan McClellan, "Smart Cities in Application: Healthcare, Policy and Innovation", Springer.

3 Schahram Dustdar, "Smart Cities: The Internet of Things, People and Systems", Springer, 2017.

WEB REFERNCES:

1 IoT-From Research and Innovation to Market Deployment_IERC_Cluster_eBook_978-87-93102-95-8_P.pdf

MOOCS:

1 https://www.coursera.org/specializations/developing-industrial-IoT

2 https://www.coursera.org/learn/smart-cities

20EC3055 – Systems for Smart Cities & Smart Villages

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study of smart cities/villages and sub-systems	**3**	**2**
CO2	Study of systems for smart villages.	**3**	**2**
CO3	Study of smart systems for smart cities.	**3**	**2**
CO4	Study of advanced topics and case studies related to industrial systems and global systems.	**3,5**	**2**

Syllabus:

Introduction to Smart Systems: Characteristics of smart systems, Development and challenges of smart systems, Type of Smart Systems, Definition of Smart Cities, Smart Villages and Smart Living, Sub-Systems: Local requirements, Issues and Solution.

Systems for Smart Villages: Architecture of Smart Village System, Modules for Smart Village, Ration Management system, Notification Management system, Milk Dairy Management system, Labor Management system ,Tax Payment system and Smart Agriculture management System, Introduction to Broad-band, Wi-Fi, Crop Price, Commodity Price, e-Governance privacy and security.

Systems for Smart Cities: Architecture of Smart cities System, Modules for Smart Cities, Data Aggregation of Smart Cities and Security, Future Industry concept, Oil and Gas Industry, Home Management and e-Health. Smart Water/Electricity Billing, Energy Saving, Smart Grid, Smart Waste Management, Parking, Traffic Management, Policing, Monitoring, Pollution Control etc.

Next Generation Smart Systems: System of Smart Systems, Connected and Autonomous Vehicle Data Ecosystem , Topology of Data Ecosystems , Directed data ecosystems, Acknowledged data ecosystems, Collaborative data ecosystems, Virtual data ecosystems, Incrementally Evolving Systems Engineering: Cognitive Adaptability, Smart Industrial Systems, World's Smart Cities, Global Systems

Text Books

1 Schahram Dustdar, "**Smart Cities: The Internet of Things, People and Systems**", Springer, 2017.

Web References

1 https://nptel.ac.in/courses/106105166/47
2 https://1000projects.org/online-smart-village-monitoring-system.html
3 https://www.youtube.com/watch?v=LlhmzVL5bm8&list=PL9ooVrP1hQOGccfBbP5tJWZ1hv5sIUWJl
4 https://www.youtube.com/watch?v=Br5aJa6MkBc
5 https://www.youtube.com/watch?v=m45SshJqOP4
6 https://www.youtube.com/watch?v=D3yrk4TaIQQ

VLSI
20EC3061 – LOW POWER VLSI

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the physics of power dissipation including short circuit power, dynamic power and leakage power, techniques that makes a low power circuit and introduction to simulation power analysis.	**1,2**	1
CO2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits.	**1,2,3**	2
CO3	Apply low power techniques at gate level, architecture level and system levels.	**1,2,3**	2
CO4	Illustrate essential tasks in algorithm and architecture level low power design environments and Apply low power clock tree distribution techniques to create low power devices.	**1,2**	2

Syllabus:

Low Power CMOS VLSI Design: Sources of Power Dissipation, Static and Dynamic Power Dissipation, Active Power Dissipation, Designing for low-power, Circuit techniques for leakage power reduction.
Simulation and Power Analysis: SPICE circuit Simulation, Discrete Transistor Modelling and Analysis, Gate level logic simulation, architecture level analysis, Date correlation analysis in DSP systems, monte carlo simulation. Random Logic Signals, Probability and Frequency, Probabilistic power analysis techniques, signal entropy.
Low Voltage, Low Power Adders and Multipliers: Standard Adder cells, CMOS Adder's architectures, Bi-CMOS Adders, Low-voltage, Low-power design techniques, Current-mode adders. Low Voltage Low-Power Multipliers Introduction, Overview of Multiplication, Types of Multiplier Architectures, Booth Multiplier, Wallace Tree Multiplier.
Low-Voltage, Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM

Text Books

1 Kiat-Seng Yeo, Kaushik Roy, Low-Voltage, Low-Power VLSI Subsystems –TMH Professional Engineering.

2 Gary K. Yeap, Practical Low Power Digital VLSI Design –Kluwer Academic Press, 2002.

Reference Books

1 Rabaey, Pedram, “Low Power Design Methodologies” Kluwer Academic.

2 Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley.

3 Yeo, “CMOS/BiCMOS ULSI Low Voltage Low Power” Pearson Education.

20EC3062 – ALGORITHMS FOR VLSI DESIGN AUTOMATION

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the VLSI design methodologies and design rules.	**1**	1
CO2	Analyse the basic concept of floor planning, routing and simulation.	**2**	2
CO3	Study of the modelling process.	**1,3**	2
CO4	Study of the synthesis process including FPGA and automation of MCMs.	**1,3,6**	2

Syllabus:

Introduction to VLSI Design & Algorithms: Complexity Issues and NP-hardness, Basic Algorithms, Basic Data Structures, Graph Algorithms for Physical design. Partitioning: Classification of Partitioning Algorithms, Group Migration Algorithms, Simulated Annealing and Evolution, Other Partitioning Algorithms. Computational complexity, Design automation tools.

Floor Layout and Modelling: Floor planning, Chip planning, Pin Assignment. Placement: Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algorithms, Modelling

Hardware Models and Routing: Classification of Routing Algorithms, Global Routing, Maze Routing Algorithms, Line-Probe Algorithms, Shortest Path Based Algorithms, Steiner Tree based Algorithms, Single-Layer Routing Algorithms, Two-Layer Channel Routing Algorithms, Three Layer Channel Routing Algorithms Multi-Layer Channel Routing Algorithms, Switchbox Routing Algorithms. Scheduling Algorithm, High Level Transformations.

FPGA Technologies: Physical Design Cycle for FPGAs, FPGA Architecture and PIN Diagram, Physical Design Automation of MCMs: MCM Physical Design Cycle, Partitioning, Placement, Routing.

Text Books

1 Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" 3rd edition, Springer International Edition.
2 S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley 1999.

Reference Books

1 Hill & Peterson, "Computer Aided Logical Design with Emphasis on VLSI" Wiley,1993.
2 Wayne Wolf, "Modern VLSI Design: Systems on silicon" Pearson Education Asia, 2nd Edition.

20EC3063 – ASIC & FPGA CHIP DESIGN

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Study and design of combinational and sequential circuits using PLDs and state machines.	**1, 3**	2
CO2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	**3, 11**	2
CO3	To study PLD structures and design process. Study of different CPLD and FPGA architectures	**1, 3**	2
CO4	To understand different physical process.	**3,11**	2

Syllabus:

Programmable Logic Design: Combinational Logic: PLDs – ROM, PLA, PAL. Analysis of Clocked Sequential Circuits: State table, State diagram, State Equation, State reduction, state Assignment. Flip Flop Excitation Tables, Design Procedure. Verilog Programming.

ASIC Design: Full Custom Design; Semicustom Design; Standard Cell Based ASIC, Gate Array Based ASIC, Programmable Logic Devices, CPLDs, FPGA, ASIC Design Flow, Economics of ASICs, ASIC Cell Library. Programmable ASICs: The Antifuse, Static RAM, EPROM and EEPROM. MOS Programmable Logic Device (PLD).

Programmable Logic Devices: Sequential PLD; Complex PLD; Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Complex Programmable Logic Devices (CPLDs): Introduction, Altera Series- MAX 5000/7000, FLEX Logic 10000, AMDs – CPLD (Mach 1 to 5), Cypress FLASH 370 Device technology.

Designing Arithmetic Building Blocks: Introduction, The Adder: Definition, Circuit and Logic Design, The Multiplier: Definition. The Shifter: Definition. Memories, ROM, ROM architecture, types of ROM, applications. RAM, RAM Architecture, static & dynamic RAM.

Text Books

1 Michael John Sebasatian Smith, “Appliction Specific Integrated Circuits” Pearson Education.
2. M. Morris Mano, “Digital Logic and Computer Design", Pearson.
3. Debaprasad Das, “VLSI Design”, Oxford – 2011.

Reference Books

1. Bob Zeidman, “Designing with FPGAs and CPLDs”, CMP Books, ISBN: 1-57820-112-8.
2. Stephen Brown and Zvonko Vranesic “Fundamentals of Digital Logic with Verilog Design” McGraw-Hill.
3. Pak K. Chan, Samiha Mourad, “Digital Design Using Field Programmable Gate Array”, Pearson Education – 2009.

20EC3064 – VLSI SUB-SYSTEM DESIGN AND DESIGN FOR TESTABILITY

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the different design and programmable design techniques.	**1,3**	1
CO2	Analyse different memory and array subsystems.	**1,3**	2
CO3	Analyse the fault tolerant system can be viewed as a design moving through different abstraction levels, a historical view of the development of VLSI system.	**1,3**	2
CO4	Examine The test pattern generation for BIST and specific BIST architectures.	**1,3,5**	2

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell-based design; full custom design; Design flow; Design Economics. Data path Subsystems: Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off.
Memory and Array Subsystems: SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories. Special purpose Subsystems: Packaging; power distribution; I/O pads.
Fault Tolerant Design: Importance of fault tolerance, Basic concepts of fault tolerance, Static redundancy, schemes of fault redundancy, Time redundancy, Software redundancy, Fail-Safe Operation, Fault table method, kohavi algorithm, Path sensitization, Boolean difference.
Design for Testability: ATG for SSFs in combinational and sequential circuits, Detection of bridging faults, Functional fault testing models, Ad Hoc design and design for testability techniques, Generic scan-based designs, some advanced scan concepts, BIST architectures.

Text Books

1 Neil H. E. Weste, David. Harris and Ayan Banerjee, “CMOS VLSI Design” - Pearson Education, Third Edition, 2004.
2 Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, “Digital Systems Testing and Testable Design” Revised Printing, IEEE Press, New York.

Reference Books

1 Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, Second Edition.
2 P. K. Lala,” Fault Tolerant and Fault testable hardware design”, BS Publication
3 Michael L. Bushnell &Vishwani D. Agrawal,” Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits”, Kluwar Academic Publishers. 2000.
4 N.N.Biswas “Logic Design Theory” PHI.

20EC3065 – SEMICONDUCTOR MEMORIES & MEMS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyse the different memory and array subsystems	**1,2**	1
CO2	Study of nanoelectronics based ferroelectrics and solar cells	**1,3**	2
CO3	Study of various MEMS and NEMS materials and applications.	**1,3**	2
CO4	Understand the basic concept reliability and modeling of faults as a requisite for achieving manufacturing quality of semiconductor devices and then identifies difficulties in VLSI testing.	**1,3**	2

Syllabus:

Basics of Semiconductor Memories: Memory Architectures and building blocks, Static RAMs and Dynamic RAMs. Basics of SRAM cell, CMOS SRAM cell, design of CMOS SRAM cell, READ and WRITE operations. Basics of DRAM, differential operation in dynamic RAMs, READ and WRITE operations, area considerations. Peripherals of SRAM. Non-volatile Memories: Memory timing definitions, Memory architecture, Masked Read Only Memories (ROMs)- Programmable Read Only Memories (PROMs), Erasable (UV) Programmable Read only Memory (EPROMs) Electrically Erasable PROMs (EEPROMs), Content Addressable Memory (CAM), Programmable Logic Array.

Nanoelectronics based Ferroelectrics and Solar cells: Nanoelectronics, Moors Law, Quantum phenomena for Nanoelectronics, Quantum dots, Nano ferroelectrics, Magneto resistive random-access memory (MRAM), DRAM Circuit operation Principle, Memory Peripheral Circuitry: The address decoders, sense amplifiers, voltage references, drivers/buffers, Timing and Control. Basic principle of capacitor and Super Capacitor, Types of Super Capacitor, Super Capacitor energy storage mechanism, Photons, Photo Voltaic Effect, PEC Solar cells, Types of solar cells, Dye sensitized and organic solar cells.

Overview of MEMS and NEMS: Materials for MEMS: Semiconductors, Metals and Metal alloys, Ceramics, Polymers, Silicon and other substrate materials. Introduction to Micro-Nano fabrication: Cleaning, Oxidation, Diffusion, Mask making, Lithography, Etching, Ion Implantation, CVD, PVD, Metallization; Surface micromachining and Bulk Micromachining, DRIE, LIGA, Fabrication of high aspect ratio deformable structures. Mircosensors and Microactuators: Optical, chemical, thermal, gas, pressure, bio and mechanical sensors, Nanosensors.

Design for Testing and Misc. Topics: Basics of Testing: Fault models and fault simulation, Test generation for Combinational Circuits. Current sensing-based testing. Classification of sequential ATPG methods. Fault collapsing and simulation. CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis. Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing. Reliability, Yield and Power dissipation in Memories. Signal to Nosie ration, Memory yield, sources of power dissipation in memories, partitioning of the memory, Addressing the active power dissipation. Semiconductor memory trends and evolutions.

Text Books

1 Tai-Ran Hsu, MEMS and Microsystems – Design, Manufacture, and Nanoscale Engineering, Second Edition, John Wiley & Sons, Inc., New Jersey, 2008.
2 Reza Ghodssi, Pinyen Lin, MEMS Materials and Processes Handbook, Springer, New York, 2011.
3 Introduction to Nanotechnology – Charles P.Poole Jr and Frank J.Owens .,Wiley India Pvt.Ltd.,2007.
4 Nanotechnology and Nanoelectronics – W.R.Fahrner .,Springer., 2006
5 N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.
6 W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann, Publishers. 2006.

Reference Books

1 H. Baltes, O. Brand, G. K. Fedder, C. Hierold, J. G. Korvink, O. Tabata, Enabling Technology for MEMS and Nanodevices, Wiley-VCH, Weinheim, 2004.
2 C.P. Wong, Kyoung-Sik (Jack) Moon, Yi Li, Nano-Bio- Electronic, Photonic and MEMS Packaging, Springer, New York, 2010.
3 Sandra Carrara, Nano-Bio-Sensing, Springer, New York, 2011.

20EC3066 – ANALOG & DIGITAL, IC DESIGN AND APPLICATIONS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the functionality and Electrical Properties of MOS Devices. Understand concept of various amplifiers.	**1,3**	2
CO2	Analysing and design of passive & active current mirrors and switched capacitor technique.	**1,3**	2
CO3	Illustrate the design procedure of static and dynamic CMOS circuits. Illustrate the design procedure of sequential logic gates and clock synchronization.	**1,2,3**	2
CO4	Discuss the design procedure of arithmetic building blocks and memories.	**1,2,3**	2

Syllabus:

Amplifiers: MOSFET basics, large and small signal models of MOSFET, second order effects (such as, channel length modulation, Substrate bias effect). Single Stage (CS, CG, CD) amplifiers, single stage amplifiers with different loads, Cascode Stage, Differential and Operational-Amplifiers.
Current Mirrors and Switched Capacitor Technique: Introduction of MOS Current Mirrors and types. Basic MOS Current Mirrors, Cascode current mirror, Switched-capacitor technique, Filter realization using switched capacitor technique.
Designing Combinational and Sequential Logic Gates in CMOS: Introduction, Static CMOS Design, Dynamic CMOS Design, Static Sequential Circuits Dynamic Sequential Circuits, Timing Issues in Digital Circuits**:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization.
Designing Arithmetic Building Blocks: Introduction, The Adder: Definition, Circuit and Logic Design, The Multiplier: Definition. The Shifter: Definition. Memories, ROM, ROM architecture, types of ROM, applications. RAM, RAM Architecture, static & dynamic RAM.

Text Books

1 BehzadRazavi, "Design of Analog CMOS Integrated Circuits", Tata Mc Graw Hill, (2005)
2 S. Kang and Y Leblebici, "CMOS Digital Integrated Circuit" Tata Mc Graw Hill, (2005), 3rd edition.
3 Jacob Baker, "CMOS Mixed Signal Circuit Design", John Wiley, (2008)

4 Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003

Reference Books

1 Neil H. E. Weste and David. Harris Ayan Banerjee, "CMOS VLSI Design" – Pearson Education, 1999.

2 Gray& Mayer, "Analysis & Design of Analog Integrated Circuits", 4th edition, Wiley, (2001).

ROBOTICS & AUTOMATION
20EC3071 – CONTROL SYSTEMS & INTRODUCTION TO ROBOTICS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Classify various types of robotic configurations	1,2	2
CO2	Select appropriate type of drive, gripper and sensor for Robot	1,2	3
CO3	Recommend appropriate robot configurations for various applications.	1,2	3
CO4	Understand various implementation issues for robotics	1,2	2

Syllabus:

***Control System Basic Concepts*:**

Basics: Terminology, Examples, Open Loop, Closed Loop Control Systems, Types of control systems, Errors, Error Margins. Mathematical Models of physical systems: Formulation of Differential equations for Transfer Functions of DC & AC Servomotors.

Block diagram of control systems; Signal flow graph, Mason's gain formula.

***Time and Frequency Domain Analysis*:**

Standard Test *signals* – Step, Ramp, Parabolic and Impulse; Impulse Response.

Characteristic Equation of Feedback systems, Transient Response of First order and Second order Systems, Steady state error and Error constants. Introduction to *PID* and *PID Controllers* *Stability analysis:* Concept of stability and conditions for stability, Routh – Hurwitz criterion (optional), dominant poles of *transfer function*. *Root Locus Technique:* Root Locus concept, basic properties, magnitude and angle conditions, effects of adding poles and zeros to G(s) H(s). *Frequency response*: Specifications, correlation, Bode-plot, phase margin, gain margin.

***Introduction of Robotics*:**

Types of robots, Classification, usage, and the diverse *Applications* of Robots.

Mathematical Representations of Robots: Position and orientations of rigid body, Homogeneous transformations, Representation of joints, Link representation using D- H parameters. Different kinds of *Actuators:* Stepper, DC servo and AC motors
Different Types and Ranges of *Sensors:* Internal and External sensors.
Common Sensors – encoders, tachometers, strain gauge-based force-torque sensors, proximity and distance measuring sensors

***Kinematics, Dynamics Motion Planning and Control*:**

Kinematics: for Robotic Arm and Robots, Planning of Manipulator Trajectories, Control and Kinematics, Serial and Parallel manipulators, Direct and Inverse Kinematics.

- *Degrees of Freedom & Dynamics:* Parallel mechanisms, Constraint equations, Velocity and Static Analysis, Formulation of Equations of Motion, Recursive Dynamics.
- *Simulations* of robots using MATLAB / PHYTHON.
- *Robot Control Techniques*, Position and Force Control, Modeling and Control of Robots. Design of slip-free Wheeled Mobile robots.
- *Advanced Topics in Robotics:* Nonlinear dynamics, Chaos HMI, BMI and Humanoid.

Text Books

1 J. Nagrath & M Gopal, "Control System Engineering", 5th Edition, New Age International Publication, New Delhi (2011).

2 B. C. Kuo," Automatic Control Systems", Eighth Edition, Prentice Hall India Publications, New Delhi , (2010).

3 A. Ghosal, "Robotics: Fundamental Concepts and Analysis", Oxford University Press, 2nd reprint, 2008.3.

4

5 1. J. Nagrath & M Gopal, "Control System Engineering", 5th Edition, New Age International

6 Publication, New Delhi (2011).

Reference Books

1 K Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall India Publication, New Delhi , (2010).

2 M. Gopal, "Control Systems Principles and Design", Fourth Edition, Tata Mc-Graw Hill Publications, (2012).

3 K. Fu, R. Gonzalez, and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw - Hill, 1987.

20EC3072 – AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Autonomous Vehicles, dynamics and design electronics to complement those features.	1,2	2
CO2	To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms. To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software	1,2	3
CO3	To understand the concepts of Automotive Electronics and its evolution and trends. Automotive systems & subsystems overview	1,2	3
CO4	Design and implement the electronics that attribute the reliability, safety, and smartness to the embedded to Automotive Electronics protocols and autonomous Vehicles testing, vibration.	1,2	2

Syllabus:

(i)Introduction to Autonomous Vehicles [4-5]

Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Vehicle Operating Software; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Society of Automotive Engineers Levels of Automation; Major Functions of physical Ecosystem of an Autonomous Vehicle (cameras, radar, lidar, gps, ultrasonic sensors, central computer, DRSC-based Receiver); Autonomous Vehicle architecture (JAUS & GOA);

(ii) Driver Assisted/Driverless Vehicles, Connected Vehicles: [4-5]

Basic control system applied to Drive Assisted, Driverless, Connected Vehicles; Overview of the operation of Electronic Control Unit (ECUs); Basic cyber-physical system theory and autonomous vehicles; Comparison chart of deriver assisted vs driverless vehicle and connected Vehicles vs Autonomous Vehicles.

Automotive Sensors [4-5]

Role of sensors and actuators in autonomous vehicles; Schematic principle of Autonomy and automotive sensors; Sensor characteristics**,** Hall phase, Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Exhaust gas oxygen concentration, Throttle plate angular position, Crankshaft angular position/RPM, Manifold Absolute Pressure (MAP), Differential exhaust gas pressure and Air bag sensors, Sensor Testing and Calibration **Automotive Actuators (AA) :** Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Transmission (AT) [4-5]: Transmission fundamentals, Types MT, AT, CVT and DCT, ATS, Clutch, characteristic studies of Gear Box, epicyclic gear arrangement. **Microcontrollers for Automotive (AM):** Criteria to choose the right microcontroller/processor for various automotive applications; Understanding various architectural, Dynamometer testing. Vehicle Control, Power train, Driver Information, Motor Control Technologies: Toshiba offers microcontrollers, Vector Engine (VE), Automotive MCU

Automotive Control System & Model Based Development [1-2]: Control system approach in Automotive Electronics, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE toolboxes.

Automotive Electronics (AE) [4-5]

Fundamentals of Automotive Electronics (FAE): Principles of automotive systems **Advanced driver-assistance systems (ADAS):** Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, ADAS in Toyota, Nissan, Honda, Hyundai, Volkswagen, BMW, General Motors. **Bluetooth low energy and the automotive (BLE-AE):** Functional view of BLE; BLE-enabled Vehicle access block diagram; operation of Smart vehicle access using BLE, Driver assistance and personalization using BLE-AE, Piloted/assisted/remote parking BLE-AE.

Automotive Wireless (AW)[4-5] : Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Wireless Access in Vehicular Environments (WAVE) amendment to IEEE 802.11; IEEE 802.11ac WLAN PHY and dual-band (2.4 GHz/5 GHz) support ; EEE 1609 - Family of Standards for Wireless Access in Vehicular Environments (WAVE). **Automotive GPRS Vehicle Tracking (AGPRS-VT)** Vehicle Tracking System; Principle of working for Vehicle Tracking system. GPS and GPRS tracking system

Embedded to Automotive Electronics and autonomous Vehicles [4-5]:

Controlled Area Network (CAN): Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication. **Local Interconnect Network (LIN) :** Basic, LIN workflow concepts, LIN frame, header concepts, IN Checksum Calculation and Verification, applications.

FlexRay Consortium [5-6]: Basics, Working, Clock synchronization, Single Edge Nibble Transmission) protocol: SENT protocol structure, Basic Concepts and Fast Channel Data

Transmission, **Media Oriented Systems Transport (MOST):** Principles of communication operations, Competing standards. **Vehicle Area Network (VAN):** basic architecture of VAN, operational view of VAN, Integrated to Automotive Electronic Protocols: EBD, Electronics stability programs (ESP), PA Industrial control system protocols: Open Platform Communications (OPC), Remotely Piloted Vehicles (RPVs); Unmanned Aerial Vehicle (UAV). **Manifold Absolute Pressure Sensor (MAP sensor):** Basic architecture, operation, applications, testing procedure of MAP. Electronic Control Units (ECU), Vehicle Networking & Diagnostics Stacks; Automotive Functional Testing: The Process Flow-diagram. HIL Testing, MIL Testing, SIL Testing.

Text Books

1 Crating Autonomous Vehicle Systems by shaoshan liu, liyun li

2 Autonomous vehicles: opportunities, Strategies, and Disruptions by Michael McGrath

3 Reinventing the automobile: personal urban mobility for the 21st century (the MIT Press) by William J. Mitchell, Chris E. Borroni-Bird, Lawrence D. Burns.

4 Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System” Prentice Hall Inc., New Jersey

5 Understanding Automotive Electronics an Engineering Perspective Seventh edition William Ribbens.

6 Automotive Power Transmission Systems Yi Zhang University of Michigan-Dearborn USA Chris MiSan Diego State University USA.

7 Automotive Embedded Systems Handbook CRC Press Taylor & Francis Group Richard Zurawski

8 Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive Robert Bosch GmbH (Ed.) 5th Edition

9 William B Ribbens "Understanding Automotive Electronics", SAE Publications, 1998

Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006.

10 Marc E. Herniter and Zac Chambers: “Introduction to Model Based System Design”, RoseHulman Institute of Technology. Rudolf Limpert, “Brake design and Safety”. SAE Publications, 2015,

Web References

1 https://toshiba.semicon-storage.com/ap-en/product/automotive/micro.html

2 https://www.tesla.com/autopilot

3 https://www.audi.com/en/experience-audi/mobility-and-trends/autonomous-driving.html

4 https://global.toyota/en/mobility/

5 https://www.mazdausa.com/

20EC3073 – ADVANCED ROBOTICS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	The objective of Advanced Robotics is an in-depth study in robot sensing; actuation; communications; control; computer vision; and path/motion planning	1,2	2
CO2	Understanding of Advanced Robotic Manipulator & Actuator (ARM & ARS), Design and analysis on Advanced Robotics Modelling.	1,2	3
CO3	To understand Advanced Level of Robotics, Depth understanding on the functional and critical operational view of Advanced Robotics	1,2	3
CO4	The objective is to study all the advanced robotics systems, Real time Environmental, application in manufacturing processes, casting, welding, painting. Understanding present advanced model and applications.	1,2	2

Syllabus:

Introduction to Robotics (ITR): [3-4]
Brief History, Types of Robots; Technology of Robots, Basic Principles in Robotics; Mathematical Representation of Robots; Robot Hardware; Obstacle Avoidance, Task Planning and Navigation; Robot Vision; Artificial Intelligence Applications of real-world Environments (Driverless, Unmanned Aerial Vehicles (UAV), and Tele-robots), Introduction to Robotic Operating System (ROS)

Robotics Foundation: [4-6]
Degrees of Freedom (DoF), Six Degrees of Freedom (6DOF), Mobility formula, Three Laws of Robotics; Asimov's Laws(AL), Dynamic Stabilization(DS), Advanced Robotics Sensors(ARS), Power Sources(PS), Force Control(FC), Ring LASER, Gyro Sensor(GS), Inertial Navigation(IN), Terrain a Mapping (TaM), Contour following direct and inverse kinematics problems and workspace,Kinematics. Motions and dimensions; Robotics Components, Power, types of Robot Sensors.

Advanced Robotic Manipulator & Actuator (ARM & ARS) [8-10]:
Industrial Robot Manipulator: Manipulator Structures, Kinematics of Serial and Parallel Manipulators, Velocity Analysis and Statics of Manipulators, Dynamic of Manipulators, Trajectory Planning and Generation(P&G), position and Force control of Manipulators, Modelling and Control of Flexible Manipulators, Modelling and analysis of Wheeled Mobile Robot; 3D LASER Doppler Vibrometer, Magnetic Levitation Control, Inverse Kinematics solution for general 6R manipulator. Joint Actuating System; Servomotor; Grippers, AR in Path Planning Algorithm, Hill-Climbing, Design Consideration Macrobiotics.
Varieties of Robots & Advanced Robotics Heterogeneity (ARH) [8-9]: Design Studies on Boston Dynamics Products: Cheetah, Atlas, SpotMini, Legged Robots, Wheeled Robots, Mobile Robots, Telerobots, Service Robots; Design considerations On: Large Robots, Miniature Robot(Swarm robotics), Auto-bots, Swarm-Robotics, Micro-bots, wheeled mobile robots, bipeds,KUKA Collaborative Robot Serie, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots, Introduction to Autonomous Electric Vehicles(AEVs).
Case Studies, Applications & Humanoid [8-10]:
[i]: Robot Assembling: Assembly of robots using Lego, Vex and Tetrix Kits – Five-minute bot, Line follower, Obstacle avoidance robot, Wall following robot; Coordinated Multi-Robot Exploration; Mapping and Localization in Non-Static Environments.
[ii]: Programming: Programming of robots using NXT software, Robot C and python programming -advanced path planning robots. **e-Yantra Firebird Kit**: Introduction, Architecture, programming using Atmel studio, Programming: Buzzer, Line following, LCD display.
[iii]: Case Studies: Multiple Robots, medical robots: image guided surgical robots, radiotherapy, cancer treatment.
[iv]: Miscellaneous Applications: Industrial /Home/Defense Applications, painting robots, image guided Surgical Robots (SR], Cancer Treatment Robot (CTR)

Textbooks

[1]. Industrial Robotics Technology, Programming and Applicationsby M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey
[2]. Ashitava Ghosal - Robotics - Fundamental concepts and analysis-Oxford University Press (2006)
[3]. Anis Koubaa, Hachemi Bennaceur, Imen Chaari, Sahar Trigui, Adel Ammar, Mohamed-Foued Sriti, Maram Alajlan, Omar Cheik hrouhou, Yasir Javed Series: Studies in Computational Intelligence Publisher: Springer, Year: 2018ISBN: 978-3-319-77042-0,978-3319770406
[4]. Springer Tracts in Advanced Robotics Volume 55 Editors: Bruno Siciliano · Oussama Khatib · Frans Groen

Reference Books

[1]. Mikell P Groover, Automation, Production Systems, and computer integrated Manufacturing‖, Prentice Hall, 2001.
[2]. Introduction to Roboticsby S. K. Saha
[3]. Introduction to Robotics–Analysis Systems, ApplicationsbyS. B. Niku.
[4]. Robotics: ―Fundamental Concepts and Analysis by A. Ghosal
[5]. Industrial Robot Programming–Building Application for the Factories of the Future by Pires
[6]. Image Guided Interventions – Technology and Applications‖, Springer by Peters

20EC3074 – COMPUTER VISION & APPLICATIONS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Implement fundamental image processing techniques required for computer vision.	1,2	2
CO2	Apply Hough Transform for line, circle, and ellipse detections	1,2	3
CO3	Apply 3D vision techniques. Implement motion related techniques; develop applications using computer vision techniques.	1,2	3
CO4	Understands motion analysis. To study some applications of computer vision algorithms.	1,2	2

Syllabus:

Introduction to Computer Vision (CV)

Basic Block Diagram Computer Vision; Principle of Computer Vision; Perception of 2 Dimensional & 3Dimensional Transformation (2DCVT &3DCT); 3D Rotation; Histogram, Texture Analysis;, Image formation, Geometric Primitives and transformations, Geometric Primitives, 3D to 2D Projections, Lens distortions, Color, Compositing and matting, Point, Pixel transforms, Histogram equalization, Application: Tonal adjustment, 4D to 11D Transformation on CV.

Optical Features Extraction (OFE)

Overview of Feature Extraction on Computer Vision ; Edges, HOG, SIFT, SURF, DTW, Gabor Filter, Scale Space Analysis; Analysis Edges, Edge detection , Edge linking , Application: Edge editing and enhancement ,A comparative study of CFs, LBP, HOG, SIFT, SURF, and BRIEF for security and face recognition , Gabor filter for image processing and computer vision.

Video Features & CV Methods

Optical Flow, Optical Flowrate, Elastic Band, Boundary Detection.

Optical Flow-Rate ,Optical Flow Estimation,Ealstic Band ,Selection of Terminal Point of the Line, Texture Segmentation, Edge Flow and Anisotropic Diffusion, Edge Flow Definition ,Edge

Flow Intensity ,Edge Flow Texture, Edge Flow , Edge Flow Based on Gabor Phase , Edge Flow Integration , Edge Flow Propagation and Boundary Detection.

Pattern Analysis-Dimension Reduction

VQ, ICA, KNN, PCA, LDA, Classifiers: GMM, SVM, CNN, DNN Gaussian Mixture Model and Deep Neural Network Recognizing faces with PCA and ICA, K-nearest Neighbors (KNN) ,Classification Model LDA in Python for Computer Vision **,**LDA in Python for Computer Vision, Deep Learning for Computer Vision, Support Vector Machines (SVM), Image Processing with the Computer Vision API vision field, LDA in Python for Computer Vision, Robust Principal Component Analysis for Computer Vision, Diagnosis and Treatment of Computer Vision Syndrome, Image Classifier using CNN.

Text Books

1 Ayman Al Falou -Advanced Secure Optical Image Processing for Communications APRIL 2008
2 Richard Szeliski- Computer Vision: Algorithms and Applications March 30, 2008

References

3 Noah Snavely's - Introduction to Computer Vision class at Cornell Tech (Spring 2019)
4 Bharath Hariharan's - Computer Vision class at Cornell (Spring 2019)
5 Pascal Fua's - Introduction to Computer Vision class at EPFL (Spring 2019)
6 Ioannis Gkioulekas's - Computer Vision class at CMU (Spring 2019)
7 Ioannis Gkioulekas's - Computational Photography class at CMU (Fall 2018)
8 Bill Freeman, Antonio Torralba, and Phillip Isola's 6.819/6.869- Advances in Computer Vision class at MIT (Fall 2018)
9 Alyosha Efros'- Image Manipulation and Computational Photography class at Berkeley (Fall 2018)
10 Alyosha Efros, Jitendra Malik, and Stella Yu's CS280- Computer Vision class at Berkeley (Spring 2018)
11 Deva Ramanan's - Computer Vision class at CMU (Spring 2017)
12 Trevor Darrell's - Computer Vision class at Berkeley
13 Antonio Torralba's - Advances in Computer Vision class at MIT
14 Michael Black's - Introduction to Computer Vision class at Brown
15 Kristen Grauman's - Computer Vision class at UT Austin
16 Alyosha Efros' - Computational Photography and Learning-Based Methods in Vision classes at Carnegie Mellon 9092372797
17 https://www.javatpoint.com/computer-graphics-elastic-or-rubber-band-techniques
18 http://www.cs.jhu.edu/~misha/ReadingSeminar/Papers/Ma00.pdf
19 https://www.geeksforgeeks.org/image-classifier-using-cnn/
20 http://vqlsr.com/vision-services/computer-vision.html

20EC3075 – HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics.	**1,2**	**1**
CO2	Understanding the HMI Technologies such as GMOS Models, CMN-GOMS, Fitts Laws, Hick-Hyman Laws, Norman's 7 Principles.	**1,2**	**2**
CO3	Understanding the concept of Brainwaves & BMI	**1,2**	**2**
CO4	Analysing Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FEM]	**1,2**	**2**

Syllabus:

(a) Intro. to HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics

Introduction to the course and to HMI/HCI, HMI/HCI Its history Relation to Ergonomics and Human Factors Problems and challenges Recurrent HMI Themes, Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques.

Design rules Authority vs. generality Principles, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS, Fitts' law and Hick-Hyman's law, Guidelines in HCI: Norman's seven principles, Norman's model of interaction, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough.

(c) Brainwaves & BMI: Alpha, Beta, Theta, Gamma wave, Brain-Control Interface, ARMA Model

Introduction to ***Brain Control Interface*** Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI Brain signal acquisition, Experiment design and data analysis (with explanation of one-way ANOVA), ARMA Model

(d) Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FSM] Task modelling and analysis through Hierarchical task analysis (HTA), GUI design for a mobile phone based Matrimonial application, Employment Information System for unorganized construction workers on a Mobile Phone. Dialog Design using FSM (finite state machines), Cognitive architecture, Object Oriented Modelling of User Interface Design.

Text Books:

1. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.

Reference Books:

1. B. Schneiderman; Designing the User Interface, Indian Reprint, Addison Wesley 2000.
2 Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012

Web References

1 https://www.expertsnotes.com/2016/04/jntuk-r-10-4-2-cse-human-computer.html
2 https://nptel.ac.in/courses/106103115/4
3 http://www.eolss.net/sample-chapters/c18/e6-43-37-06.pdf
4 https://www.Tutorials.in/How_Does_Your_HMI_Design.
5 Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006

20EC3076 – DESIGNING AUTOMATION SYSTEMS & ASSISTIVE ROBOTIC SYSTEMS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Acquire knowledge about the fundamental principles, hierarchy level, architecture, functions and implementation strategies of Distribution Automation Systems (DAS) and Distribution Management Systems (DMS).	1,2	2
CO2	Provide solutions for Automation in Home, industry, Advanced Research Laboratories	1,2	3
CO3	Understanding industrial robots and robotics arms, cooperative robotics arms, automated kitchen, studying about various home automation.	1,2	3
CO4	Study of the robot assistive technology; understanding the Human Activity Assistive Technology (HAAT) model. Understanding of the Assistive Robotic Manipulators (ARM) Justify the use of robots in rehabilitation. Discuss the current international safety standards for robotic assistive technologies.	1,2	2

Syllabus:

Introduction to Automation Systems-Definition, types, merits and Criticism- Architecture of Industrial Automation Systems-Manufacturing plants and operations-Automation Strategies-Basic elements of Automated system- Advanced Automation Functions-Levels of Automation. Industrial control Systems- Process, Discrete manufacturing industries-Continuous and Discrete Control systems-An overview of Computer process control-Fundamentals of automated assembly system. Actuators& Sensors, Fluid Power and Electrical Actuators Piezoelectric Actuator; Sensors for position, motion, force, Strain and temperature

Home Automation: Introduction Home Automation; Determining Home Automation Needs (and Wants); Automating Inside Your Home: Keeping Your Cool or Turning Up the Heat, Automated Lighting, Safe, Sound, and Hunkered Down, Home, Home on the Automatic Range: The Automated Kitchen, Monitoring Water Use and Detecting Leaks, Smart Home Entertainment, Automating Outside Your Home: Checking the Weather, Ten Easy Ways to

Begin Automating in Home: Philips Hue products.

Industrial Robots and Robotic Arms: Study of Basic Functionality of industrial Robots (RIPA) versions, Operations of Cooperative Robotic Arms; Robotics Arms in Advanced Automation; Industry Robots in conveyor Belts operations, robots in industry real time embedded systems, Robotic Arm Coordinates and Home Position; Robotic Elbow; An Intuitive Teleoperation of Industrial Robots: Approach Manipulators by Using Visual; Tracking Over a Distributed System; Baggage Collection Automation Applications for Human Safety: Dangerous domains for humans, (Mine Detection), Hazardous domains for humans (chemical fumes etc.), Nuclear Biological Chemical warfare, dangerous exploratory missions UAVs, unmanned Rockets, Mars Mission, Chandrayaan.

Assistive Robotic System (ARS): Fundamentals of Robotic Assistive Technologies; Assistive Robotic Manipulators (ARM): Principles of Assistive Robotic Manipulators, Working Definition of Assistive Robotic Arms, functionality of the Assistive Robotic Arms, feature and limitation ARM; Rehabilitation robotics; Surgical robotics; Assistive Robots in Healthcare/Medical: Medical Device Packaging, Lab automation, Neurosurgery, Cutting Bone!, Therapeutic massage; Case studies on Assistive Robotics Systems in Healthcare /Medical Firm forms: Telepresence, Surgical Assistants, Rehabilitation Robots, Medical Transportation Robots, Sanitation and Disinfection Robots, Robotic Prescription Dispensing Systems; collaborative study on Socially Assistive Robotics for Personalized Education for Children; Best Robot Assistants Comparison :Anki Cozmo, Mibro, littleBits Star Wars Droid Inventor Kit, iPATROL RILEY, Beam System Remote Technology, ector Robot by Anki, Sphero BOLT App.

Text Books

1. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.
2. N.Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Syetms, Printice Hall India Pvt. Ltd.
3. Home Automation For Dummies; Published by: John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030-5774, www.wiley.com Copyright © 2015 by John Wiley & Sons, Inc., Hoboken, New Jersey
4. and J. Pratt. Mercury Learning and Information, 2016. ISBN: 978-1-942270-04-1.)
5. Robotics, Automation, and Control in Industrial and Service Settings Zongwei Luo
   South University of Science and Technology of China
6. Robotic Assistive Technologies Principles and Practice, Edited by Pedro Encarnação and Albert M. Cook Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

Reference Books

1. Mikell P Groover,Automation, Production Systems, and computer integrated Manufacturing‖, Prentice Hall, 2001.
2. Deb S R.and DebS., ―Robotics Technology and Flexible Automation‖, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Manual Prepared by the Department of Robotics and Automation Engineering, 2015.
4. Robotic Prosthetic Limbs Ruwan Gopura,1 Kazuo Kiguchi,2 George Mann,3 and Diego Torricelli

SIGNAL PROCESSING
20EC3081 – SPEECH SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of speech signal processing	**1,3**	**1**
CO2	Understand and applications of various transformation techniques for filter.	**1,3**	**1**
CO3	Understand the concepts and methods of aliasing, auto correct and filtering.	**1,3**	**1**
CO4	Analysis and understand advance topics in speech signal processing.	**5**	**4**

Syllabus:

SPEECH FUNDAMENTALS: Production and Classification of Speech Sounds; Acoustic Phonetics – Vowels, diphthongs, fricatives etc., Speech parameters-Speech production, Labelling.
TRANSFORMATIONS FOR SPEECH SIGNAL PROCESSING: Fourier Transformation, Design of Filters- Wide band and Narrow Band- Hilbert transform- Auto correlation and Hilbert huang transforms for pitch estimation- STFT- STFT representation of speech - Z transform and Pole Zero concepts, LTI, Modelling of speech: Inverse filtering, Pole zero, Z transform.

ANALYSIS AND SYNTHESIS OF SPEECH:
Speech Analysis: Time domain: Analysis and Synthesis of Pole-Zero Speech Models; Aliasing, Spectral: Short Time Fourier analysis - filter bank design - speech coding – subband coding of speech - transform coding - channel vocoder - vector quantizer coder. introduction to LPC.
Speech synthesis - Pitch extraction algorithms, MFCC- autocorrelation pitch trackers - voice/unvoiced detection - homo morphic speech processing - homomorphic systems for convolution - complex cepstrum - pitch extraction using homomorphic speech processing.

Introduction to vowel synthesis.

ADVANCED TOPICS and APPLICATIONS OF ANN, AI and ML.

Introduction to Hidden Markov Modelling- Application of HMM: making a digit recognition system -Automatic segmentation and labelling of speech based on HMM- speaker verification systems – speaker identification Systems - ANN,CNN, ANN and CNN for Automatic speech and speaker recognition- Introduction to Text to speech and Speech to text, Introduction of AI and ML based applications in speech domain.

Text Books

1. Biing-Hwang Juang, Lawrence Rabiner, B. Yegnanarayana, "Fundamentals of Speech Recognition" Pearson Education, 1st Edition 2008.
2. Lawrence Rabiner, Ronald Schafer,"Theory and Applications of Digital Speech Processing," Pearson Education, 2011.
3. Thomas parsons, “voice and speech processing”, Mcgraw hill series . 1987.
4. T.F.Quatieri, "Discrete time speech signal processing, Prentice Hall,2007.

References Books

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons.
3. Papamichalis P.E., “Practical Approaches to Speech Coding”, Texas Instruments, Prentice Hall,2003.
4. Douglas O’Shaughnessy, “Speech Communications: Human & Machine”, 2nd Ed., Wiley India, 2000
5. Dong Yu, Lie deng "Automatic speech recognition a deep learning approach, Springer 2014.

Web references

1. https://www.youtube.com/watch?v=X_JvfZiGEek
2. https://www.youtube.com/watch?v=3MjIkWxXigM
3. https://nptel.ac.in/courses/117/105/117105145/
4. https://www.youtube.com/watch?v=RBgfLvAOrss
5. https://www.youtube.com/watch?v=Xjzm7S__kBU
6. https://www.youtube.com/watch?v=gMQyGASOZO0

20EC3082 – DIGITAL IMAGE PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/ PSO	BTL
CO1	Selected, as high level mathematics are used to model 2D complex systems; The principles of mathematics help solve Image Processing problems effectively.	**1,3**	**2**
CO2	Selected, to simulate algorithms for Systems using 2D methods	**1,3**	**3**
CO3	Selected, to create a problem identifier and learner, to find solutions in complex search space.	**1,3**	**3**
CO4	Selected, with simulations that can apply 2D models to solve Image processing problems.	**5**	**3**

Syllabus:

Introduction to DIP: What is digital image processing? Applications, Fundamental steps of DIP, Components of DIP systems, Visual Perception and electromagnetic spectrum, Image Sensing and Acquisition including A Simple Image Formation Model using illumination and reflectance, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Image Operations on a Pixel Basis, Linear and Nonlinear Operations, Image transforms: 2D orthogonal and unitary transforms. Separable unitary transforms. DFT, WHT, KLT, DCT, Image Enhancement in both Spatial and Frequency domains, Basic Gray level transformation,

Image enhancement: Histogram processing Enhancement using Arithmetic and logic operations, Spatial filtering: Smoothing and Sharpening filters, Enhancement using Frequency domain:2D DFT and inverse DFT, Basics of filtering in the frequency domain, Basic filters and their properties, Frequency domain smoothing, sharpening filters, Homomorphic filtering.

Image Degradation / Restoration :process Noise Models: Gaussian, Rayleigh, Gamma, Exponential Uniform, Impulse, Salt and Pepper noise. Noise reduction: Spatial filtering approach: Mean, Order statistics filters Noise reduction: Frequency domain filtering approach: Band rejection, Band pass and Notch filters, Introduction to Segmentation: Detection of discontinuities: Point detection, Line detection, Edge detection. Gradient, Laplacian Edge linking and Boundary detection: Local processing, Thresholding for segmentation

Image Compression and colour image processing : Introduction to compression: Coding redundancy, inter pixel redundancy and Psych-visual redundancy, Image compression model. Error free compression: Huffman coding, Arithmetic coding and Bit plane coding Lossy

Compression: Transform coding Colour fundamentals, colour models: RGB, CMY/CMYK, HIS, Pseudo colour image processing, Full Colour Image processing: Smoothing and Sharpening Spatial Filtering,LZW coding,JPEG

Text Books

1 Digital Image Processing (3rd Edition) Hardcover – August 31, 2007 by Rafael C. Gonzalez, Richard E. Woods.

2 Algorithms for Image Processing and Computer Vision Paperback – December 21, 2010 by J. R. Parker.

3 García, Gloria Bueno, Oscar Deniz Suarez, José Luis Espinosa Aranda, Jesus SalidoTercero, Ismael Serrano Gracia, and Noelia VállezEnano. Learning image processing with opencv. Packt Publishing Ltd, 2015.

Web References

1 https://nptel.ac.in/courses/117105079/

2 https://nptel.ac.in/courses/106105032/

3 https://nptel.ac.in/courses/117104069/

20EC3083 – BIOMEDICAL IMAGE ANALYSIS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Fundamentals of Digital image	**1,3**	**2**
CO2	Image Enhancement in Spatial and Frequency domain	**1,3**	**2**
CO3	Image Segmentation and Compression	**1,3**	**2**
CO4	Morphological Image Processing and Advanced Topics	**5**	**2**

Syllabus:

Fundamentals of Digital image: Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two-dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2Dconvolution, Color models.

Image Enhancement in Spatial and Frequency domain: Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

Image Segmentation and Compression: Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering. Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

Morphological Image Processing and Advanced Topics: Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Diffusion Tensor Imaging.

Text Books

1 Digital Image Processing, Gonzalez and Woods- Pearson Education
2 Digital Image Processing, S. Sridhar – Oxford University Press.
3 Fundamentals of Digital Image Processing, A.K. Jain .P.H.I.
4 Digital Image Processing, William Pratt- John Wiley.

Web References

1 https://www.coursera.org/lecture/image-processing/1-introduction-to-medical-imaging-duration-07-03-QhMgY
2 https://www.csie.ntu.edu.tw/~rfchang/lab/pdf/AIT/02MIP.pdf
3 https://www.youtube.com/watch?v=3qJej6wgezA
4 https://www.youtube.com/watch?v=IcBzsP-fvPo
5 https://www.youtube.com/watch?v=twsV81UFFcE
6 https://www.youtube.com/watch?v=gmi4ah7YAi0

20EC3084 – STATISTICAL SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Generalize the properties of statistical models in the analysis of signals using Stochastic processes	**1,2**	**1,2**
CO2	Differentiate the prominence of various spectral estimation techniques for Achieving higher resolution in the estimation of power spectral density	**1,2**	**3**
CO3	Design and development of optimum filters using classical and adaptive algorithms	**1,2**	**3**
CO4	Design based on Kalman filtering and extended Kalman filtering	**2,4**	**1**

Syllabus:

Review of statistical concepts and signal modeling: Random variables, Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables, Central Limit theorem, Random processes, ergodicity, wide-sense stationary processes, autocorrelation and auto covariance functions, Gaussian Process and White noise process, Autoregressive Moving Average (ARMA) Processes. Signal Modeling: Least Square method, Pade Approximation, Pole-zero and all-pole modeling, the Autocorrelation and covariance method, ARMA models

Optimum Filtering: Linear mean square filtering, Wiener-Hoff Equation, FIR wiener filter, linear prediction and noise cancellation, causal IIR Wiener filter, causal linear prediction, Wiener deconvolution

Spectrum Estimation: Nonparametric methods: Periodogram method and its performance, Bartlett's and Welch's method, Performance comparision. Minimum variance spectrum estimation, maximum entropy method, Parametric methods: ARMA spectrum estimation, Frequency estimation

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking

Text Books

M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 2014

S. M. Kay, Fundamental of Statistical Signal Processing: Estimation Thoery Vol-I PHI-2010

M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

"Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

Jerry M. Mendel, Lessons inEstimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995

Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1985.

Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

Web References

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

https://onlinecourses.nptel.ac.in/noc18_ee33/previe

https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

https://www.youtube.com/watch?v=qqeRUgAvmzQ

https://www.youtube.com/watch?v=o1-hj6GKaFY

https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3085 – ADAPTIVE SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Comprehend design criteria and modelling adaptive systems and theoretical Performance evaluation	**1,2**	**1,2**
CO2	Design a linear adaptive processor and Kalman filters	**1,2**	**3**
CO3	Apply mathematical models for error performance and stability	**1,2**	**3**
CO4	Comprehend the estimation theory for linear systems and modelling algorithms.	**2,4**	**1**

Syllabus:

Winer Filters: FIR Wiener filters, linear prediction-forward and backward predictions, Levinson-Durbin Algorithm and lattice filter, IIR Wiener filters, non-causal Wiener filter, innovation and causal Wiener filter.
Kalman filters: Gauss-Markov state variable models; innovation and Kalman recursion, steady-state behavior of Kalman filters.

Adaptive filters: steepest descent solution of FIR Wiener filter, LMS algorithm- convergence, steady-state behavior and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation, models.
Advanced Adaptive algorithms: Normalized algorithms, Variable Step Size algorithms, Block based adaptive algorithms, Time domain and frequency domain, convergence analysis.

Text Books

1 S. Haykin, Adaptive Filter Theory, Pearson, 5ed, 2014

2 D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, McGraw Hill, 2000

3 Paula S. R. Diniz, "Adaptive Filtering, Algorithms and Practical Implementation", Third edition, Springer Publishers, 2008.

4 Ali H Syed, John Wiley and Sons, "Adaptive Filters", New Jersey, USA, 2008.

5 Farhang-Boroujeny, B., John Wiley and Sons, "Adaptive Filters-Theory and Applications", Chichester, UK, 1998.

Web References

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

2 https://onlinecourses.nptel.ac.in/noc18_ee33/previe

3 https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

4 https://www.youtube.com/watch?v=qqeRUgAvmzQ

5 https://www.youtube.com/watch?v=o1-hj6GKaFY

6 https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3086 – DETECTION AND ESTIMATION OF SIGNALS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Recognizing the fundamentals of Probability and Random Processes	1,2	1,2
CO2	Understanding the statistical decision theory and signal detection processes.	1,2	2
CO3	Explore the estimation theory and their properties	2,4	3
CO4	Analyzing the state estimation techniques	2,4	2

Syllabus:

Review of Probability and Random Processes: Probability, conditional Probability and Bayes' rule, random variables, random data, Generation of Pseudo-random noise, Moments and moment generating functions, distributions, random processes, power spectral density, ergodicity.
Statistical Decision Theory and signal detection: Bayes' criteria, binary and M-ary hypothesis testing, Maximum likelihood , Neyman-Pearson criterion, composite hypothesis testing, sequential detection, energy detector, detection in presence of noise.
Estimation Theory and properties of estimator: Introduction, Generalized likelihood ratio test, MAP and ML estimation, Uniform cost function, Mean Square estimation, Criteria for good estimator, CR inequality, Bayes' estimation, Multiple parameter estimation.
State Estimation: State-space model and the optimal state estimation problem, Prediction, Digital Discrete Kalman Filter, Weiner filter, Stored Data Weiner Filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking.

Text Books

1 Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House Inc, Norwood, MA 02062, 2005.
2 Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall New Jersey, 1993.
3 Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.

Reference Text Books

1 Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

2 Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.

3 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing, with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

4 Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

20EC3087 – BIOMEDICAL SIGNAL ANALYSIS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Basics	**1,2**	**1,2**
CO2	Modalities, Signal Processing Methods	**1,2**	**3**
CO3	Modern Biomedical Technologies & Instruments	**1,2**	**3**
CO4	Advanced Applications	**2,3**	**1,2**

Syllabus:

Basics: Sources of bio-potential, cell structure, activity, resting potential, action potential, propagation of action potentials in nerves; rhythmic excitation of heart, heart activity complexity.

Modalities, Signal Processing Methods: ECG: Pre-processing, wave form recognition, EEG: Evoked responses, averaging techniques, pattern recognition, epilepsy detection. EMG: Wave pattern studies, biofeedback and other potentials. MRI, NMR, Ultra ---------------Sound, CT-Scan, 3D Imaging Techniques.

Modern Biomedical Technologies & Instruments: Robotic Hand-evaluation, functional block diagram, operation; Tissue Diagnostics using Lasers - Diagnostic Applications of Lasers in Ophthalmology and Flow Cytometry; Remote Surgery- methodology, components; Remote Health Care monitoring systems; Health Informatic Systems.

Advanced Applications: Wavelet decomposition of physiological signals for analysis; Wavelets' approach to Heart Rate, Speech, Corona, Brain, Prosthetic; Artifacts in bio-potentials, artifact elimination methods and structures, beamforming in brain analysis.

Text Books

1 Rangaraj M Rangayyan, John Wiley and Sons, "*Biomedical Signal Analysis- A case study approach*", USA, 2ed, 2016.
2 E.N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley and Sons, 2001.
3 Cromwell, Biomedical Instrumentation and Measurements, Pearson, 2015.

4 Ronald W. Waynant, Lasers in Medicine, CRC Press, 2001

5 Edward H Shotliffe, *Biomedical informatics*, Springer, Fourth edition, 2013.

Web References

1 https://www.youtube.com/watch?v=S_U-s27nPLE

2 https://www.sciencedirect.com/topics/engineering/biopotential

3 https://www.ibiology.org/techniques/introduction-to-flow-cytometry/

4 https://www.youtube.com/watch?v=ElZU13meAK4

5 https://www.uni-muenster.de/AMM/num/Vorlesungen/Skiseminar_WS07/talks/Stefanie_Sillekens.pdf

RF & MICROWAVE
20EC3091 – MICROWAVE ENGINEERING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the various microwave devices.	**1,2**	**1**
CO2	Analysis of scattering parameters of Tee junction and passive components	**1,2**	**1**
CO3	Understand the concept of design of different microwave filters	**1,2**	**1**
CO4	Analyse the applications and advanced topics of microwave	**2,3**	**2**

Syllabus:

Microwave devices*:* Introduction to microwave Components, Klystron, TWT, Magnetron. Solid state devices: IMPATT, TRAPATT, BARRIT, GUNN and PIN.

Microwave Passive Components and Waveguide Tees: Significance of scattering parameters and formation of S-matrix for n port network. Scattering parameter analysis of E-Plane, H-Plane and Magic Tee. Directional coupler, Isolator, gyrator, circulator. Microwave bends, twists, corners and posts.

Microwave Filters and Periodic structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Microwave Applications: Microwave medical applications, X-ray, Microwave Imaging, and MRI Scanning. Communication Radar applications, Satellite RF Link Applications

Text Books	
1	Microwave devices and circuits- Samuel Y.Liao, Pearson, 3rd edition, 2003.
2	Microwave engineering passive Circuits, Peter A.Rizzi, PHI, 1999.
3	Robert E Collin, "Foundation for Microwave Engineering", McGraw-Hill
Reference Books	
1	Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", McGraw-Hill.
2	"Analysis Methods for RF, Microwave, and Millimetre-Wave Planar Transmission Line Structures", by Cam Nguyun

20EC3092 – ANTENNA DESIGN & WAVE PROPAGATION

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to identify the radiation fields and antenna fundamentals	**1,2**	**BTL**
CO2	Able to Identify different types of antennas and arrays	**1,2**	**1**
CO3	Understand the concept of antenna measurements, design and testing.	**1,2**	**1**
CO4	Study of real-world applications of various antennas.	**5**	**1**

Syllabus:

Radiation concept and antenna fundamentals: Concept of Vector Potential, Radiation of Small Current Element, Radiation of Short Dipole, Radiation from Half-Wave Dipole and its Radiation Resistance & Quarter-Wave Monopole, Antenna Parameters like Radiation Patterns, Directivity, Gain, Radiation Resistance, Polarization, Effective Length and Effective Area and Antenna efficiency

Antenna types and Arrays: Log periodic antenna, Reflector antenna, Lens Antenna, Horn antenna. Two Element Arrays, N- Element Linear Arrays – BSA, EFA, Directivity N-Element Linear Array with Uniform Spacing, Non-Uniform Amplitudes, Binomial Arrays, Principle of Pattern Multiplication.

Antenna Measurement and testing: Introduction, Impedance/VSWR measurements, scattering parameters Types of Ranges: Anechoic Chamber, Elevated Ranges, Slant Range Ground Ranges, Near Field Ranges, CATR, Radiation Pattern Measurements, Gain Measurements

Real world applications of Antennas: Antenna design for mobile applications Antenna design for vehicular applications, Antenna design for satellite applications

Text Books

1 C.A Balanis, "Antenna Theory", John Wiley & Sons, 2nd ed.
2 E.C. Jordan and K.G. Balamain, "Electromagnetic Waves and Radiating Systems". 2nd ed., Pearson
3 John D Kraus, "Antennas". 2nd ed., Mc Graw-Hill
4 S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.

Reference Books

1 3. Evans, Gray E," Antenna Measurements Techniques", Artech House, Inc
2 4. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements, Scientific Atlants, Inc

20EC3093 – RADAR ENGINEERING & NAVIGATIONAL AIDS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the essential principles of operation and design of simple radar systems and analysis of essential elements of Transmitters , Receivers and design of simple Radar Receiver	**1**	**2**
CO2	Understand various types of Radars	**1,2**	**2**
CO3	Understand the principles of various Radars systems used in different applications	**3**	**2**
CO4	Understand the basic concepts related to different systems and sensors for navigation.	**3**	**2**

Syllabus:

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. **Transmitter and Receivers**: RF Power Sources. The Radar Receivers, Receiver Noise Figure, Duplexers and Receiver Protectors, Radar Displays.

Radar types: MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation

MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters. **Tracking:** Sequential Lobing Radar, Conical Scan and Monopulse acquisition and tracking, Radars for Air Traffic Control applications.

Radar Applications:, SAR, LIDAR, OTH radar, Remote sensing radar, Airport surveillance radar, Weather / Meteorological radar, Ground penetration radar, Through-wall radar, Automobile radar.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation **Radio Ranges:** LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Text Books

1 Merrill I Skolnik, "Introduction to Radar Systems", 3rd Edition, TMH, (2003)
2 William L. Melvin, James A. Scheer, "Principles of Modern Radar", SciTech Publishing.

3 Elements of Electronic Navigation Systems", Tata McGraw-Hill,

Reference Books

1 Peyton Z Peebles Jr, “Radar Principles”, John Wiley Inc., (2004).

2 Donald R Wehner, “High Resolution Radar”, Artchtech house.

3 Radar Systems and Radio Aids to Navigation, Sen & Bhattacharya, Khanna publishers

4 J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004.

20EC3094 – MODERN ANTENNAS, MILLIMETER WAVES & APPLICATIONS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and analysis of modern antenna design	**1**	**2**
CO2	Understand the concepts of mm waves and meteorological applications.	**1,2**	**2**
CO3	Understand and analysis of mm wave circuits.	**3**	**2**
CO4	Study of applications of modern antennas and mm wave radar.	**3**	**2**

Syllabus:

Modern Antennas: Phased array antennas, active phased array antennas, Biomedical antennas, Wearable antennas, Implantable antennas.
Millimeter wave Introduction: EM Spectrum, RF Range, Meteorological applications of MillimeterWaves.
Millimeter wave circuits*:* Microstrip lines, Wave Propagation in microstrip lines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits
Applications of modern antenna, Millimeter wave Radar: Inter-vehicle Communication, Space Communication, Weather Applications, and Meteorological Applications.

Text Books

1 Robert E Collin, "Foundation for Microwave Engineering", Mc Graw-Hill
2 John D Kraus, "Antennas". 2nd ed., Mc Graw-Hill
3 C.A Balanis, "Antenna Theory", John Wiley & Sons, 2nd ed.

Reference Books

1 Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures", by Cam Nguyun.

20EC3095 – ELECTRONIC WARFARE, EMI & EMC

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concept of Electronic Warfare	**1**	**2**
CO2	Able to identify the different Jamming techniques and its methodologies	**2,3**	**2**
CO3	Understand the concept of design of EMC and components	**2,3**	**2**
CO4	Analyse, design and testing of EMI and EMC	**2,3**	**2**

Syllabus:

Basics of Electronic Warfare: Targets of Electronic Warfare Operations, A General Description of Targets of Electronic Warfare Operations, Electronic Signature, ECM, ECCM, ESM

Methods, Stealth & Applications: Mathematical Models of Signals, Systems and Techniques for Electronic jamming, Active Jamming of Radar, Passive Jamming, False Radar Targets and Decoys, Homing, Stealth Technology.

EMI & EMI Control Techniques:

EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters, EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards.

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal control, Component Selection and mounting

EMC Design Guidelines, EMI Measurement :EMC Design Guidelines Typical Sub systems in Electronic Equipment, Transmitters, Receivers
Antenna Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers. Capacitors, Inductors, Transformers, Resistors, Conductors, Ferrite Beads, Coaxial Connectors, Conductive Gaskets.
EMI Measurements: Radiated Emission Test (OATS, Anechoic chamber) , Immunity Test, ESD, Buist, Surge

Text Books

1 V P Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE

Press,

2 Bernard Kieser, “Principles of Electromagnetic Compatibility”, Artech House 3rd Edition.

3 Henry W. Ott, “Electromagnetic Compatibility Engineering”, A John Wiley & Sons publication.

4 Sergei A. Vakin, Lev N. Shustov, “Fundamentals of electronic warfare”, Artech

Reference Books

1 Clayton R Paul, “Electromagnetic Compatibility”, John Wiley.

2 Tim Williams, “EMC for Product Designer”, Elsevier.

3 PR Chatterton, “Electromagnetic Theory to practical design”, Wiley.

4 Sonia Ben Dhia, “Electromagnetic Compatibility as Integrated Circuits”, Springer.

5 Filippo Neri, “Introduction to Electronic Defense Systems”, Second Edition, Artech.

6 David L. Adamy, “Introduction to Electronic Warfare Modeling and Simulation”, Artech. 7. Richard A. Poisel, “Electronic Warfare Target Location Methods”, Second Edition, Artech.

SIGNAL PROCESSING
20EC3081 – SPEECH SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of speech signal processing	**1,3**	**1**
CO2	Understand and applications of various transformation techniques for filter.	**1,3**	**1**
CO3	Understand the concepts and methods of aliasing, auto correct and filtering.	**1,3**	**1**
CO4	Analysis and understand advance topics in speech signal processing.	**5**	**4**

Syllabus:

SPEECH FUNDAMENTALS: Production and Classification of Speech Sounds; Acoustic Phonetics – Vowels, diphthongs, fricatives etc., Speech parameters-Speech production, Labelling.

TRANSFORMATIONS FOR SPEECH SIGNAL PROCESSING: Fourier Transformation, Design of Filters- Wide band and Narrow Band- Hilbert transform- Auto correlation and Hilbert huang transforms for pitch estimation- STFT- STFT representation of speech - Z transform and Pole Zero concepts, LTI, Modelling of speech: Inverse filtering, Pole zero, Z transform.

ANALYSIS AND SYNTHESIS OF SPEECH:

Speech Analysis: Time domain: Analysis and Synthesis of Pole-Zero Speech Models; Aliasing, Spectral: Short Time Fourier analysis - filter bank design - speech coding – subband coding of speech - transform coding - channel vocoder - vector quantizer coder. introduction to LPC.

Speech synthesis - Pitch extraction algorithms, MFCC- autocorrelation pitch trackers - voice/unvoiced detection - homo morphic speech processing - homomorphic systems for convolution - complex cepstrum - pitch extraction using homomorphic speech processing.

Introduction to vowel synthesis.

ADVANCED TOPICS and APPLICATIONS OF ANN, AI and ML.

Introduction to Hidden Markov Modelling- Application of HMM: making a digit recognition system -Automatic segmentation and labelling of speech based on HMM-speaker verification systems – speaker identification Systems - ANN,CNN, ANN and CNN for Automatic speech and speaker recognition- Introduction to Text to speech and Speech to text, Introduction of AI and ML based applications in speech domain.

Text Books

1. Biing-Hwang Juang, Lawrence Rabiner, B. Yegnanarayana, "Fundamentals of Speech Recognition" Pearson Education, 1st Edition 2008.
2. Lawrence Rabiner, Ronald Schafer,"Theory and Applications of Digital Speech Processing," Pearson Education, 2011.
3. Thomas parsons, "voice and speech processing", Mcgraw hill series . 1987.
4. T.F.Quatieri, "Discrete time speech signal processing, Prentice Hall,2007.

References Books

1. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing.
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons.
3. Papamichalis P.E., "Practical Approaches to Speech Coding", Texas Instruments, Prentice Hall,2003.
4. Douglas O'Shaughnessy, "Speech Communications: Human & Machine", 2nd Ed., Wiley India, 2000
5. Dong Yu, Lie deng "Automatic speech recognition a deep learning approach, Springer 2014.

Web references

1. https://www.youtube.com/watch?v=X_JvfZiGEek
2. https://www.youtube.com/watch?v=3MjIkWxXigM
3. https://nptel.ac.in/courses/117/105/117105145/
4. https://www.youtube.com/watch?v=RBgfLvAOrss
5. https://www.youtube.com/watch?v=Xjzm7S__kBU
6. https://www.youtube.com/watch?v=gMQyGASOZO0

20EC3082 – DIGITAL IMAGE PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/ PSO	BTL
CO1	Selected, as high level mathematics are used to model 2D complex systems; The principles of mathematics help solve Image Processing problems effectively.	**1,3**	**2**
CO2	Selected, to simulate algorithms for Systems using 2D methods	**1,3**	**3**
CO3	Selected, to create a problem identifier and learner, to find solutions in complex search space.	**1,3**	**3**
CO4	Selected, with simulations that can apply 2D models to solve Image processing problems.	**5**	**3**

Syllabus:

Introduction to DIP: What is digital image processing? Applications, Fundamental steps of DIP, Components of DIP systems, Visual Perception and electromagnetic spectrum, Image Sensing and Acquisition including A Simple Image Formation Model using illumination and reflectance, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Image Operations on a Pixel Basis, Linear and Nonlinear Operations, Image transforms: 2D orthogonal and unitary transforms. Separable unitary transforms. DFT, WHT, KLT, DCT, Image Enhancement in both Spatial and Frequency domains, Basic Gray level transformation,

Image enhancement: Histogram processing Enhancement using Arithmetic and logic operations, Spatial filtering: Smoothing and Sharpening filters, Enhancement using Frequency domain:2D DFT and inverse DFT, Basics of filtering in the frequency domain, Basic filters and their properties, Frequency domain smoothing, sharpening filters, Homomorphic filtering.

Image Degradation / Restoration :process Noise Models: Gaussian, Rayleigh, Gamma, Exponential Uniform, Impulse, Salt and Pepper noise. Noise reduction: Spatial filtering approach: Mean, Order statistics filters Noise reduction: Frequency domain filtering approach: Band rejection, Band pass and Notch filters, Introduction to Segmentation: Detection of discontinuities: Point detection, Line detection, Edge detection. Gradient, Laplacian Edge linking and Boundary detection: Local processing, Thresholding for segmentation

Image Compression and colour image processing : Introduction to compression: Coding redundancy, inter pixel redundancy and Psych-visual redundancy, Image compression model. Error free compression: Huffman coding, Arithmetic coding and Bit plane coding Lossy

Compression: Transform coding Colour fundamentals, colour models: RGB, CMY/CMYK, HIS, Pseudo colour image processing, Full Colour Image processing: Smoothing and Sharpening Spatial Filtering,LZW coding,JPEG

Text Books

1 Digital Image Processing (3rd Edition) Hardcover – August 31, 2007 by Rafael C. Gonzalez, Richard E. Woods.

2 Algorithms for Image Processing and Computer Vision Paperback – December 21, 2010 by J. R. Parker.

3 García, Gloria Bueno, Oscar Deniz Suarez, José Luis Espinosa Aranda, Jesus SalidoTercero, Ismael Serrano Gracia, and Noelia VállezEnano. Learning image processing with opencv. Packt Publishing Ltd, 2015.

Web References

1 https://nptel.ac.in/courses/117105079/

2 https://nptel.ac.in/courses/106105032/

3 https://nptel.ac.in/courses/117104069/

20EC3083 – BIOMEDICAL IMAGE ANALYSIS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Fundamentals of Digital image	**1,3**	**2**
CO2	Image Enhancement in Spatial and Frequency domain	**1,3**	**2**
CO3	Image Segmentation and Compression	**1,3**	**2**
CO4	Morphological Image Processing and Advanced Topics	**5**	**2**

Syllabus:

Fundamentals of Digital image: Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two-dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2Dconvolution, Color models.

Image Enhancement in Spatial and Frequency domain: Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

Image Segmentation and Compression: Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering. Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

Morphological Image Processing and Advanced Topics: Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Diffusion Tensor Imaging.

Text Books

1 Digital Image Processing, Gonzalez and Woods- Pearson Education
2 Digital Image Processing, S. Sridhar – Oxford University Press.
3 Fundamentals of Digital Image Processing, A.K. Jain .P.H.I.
4 Digital Image Processing, William Pratt- John Wiley.

Web References

1 https://www.coursera.org/lecture/image-processing/1-introduction-to-medical-imaging-duration-07-03-QhMgY
2 https://www.csie.ntu.edu.tw/~rfchang/lab/pdf/AIT/02MIP.pdf
3 https://www.youtube.com/watch?v=3qJej6wgezA
4 https://www.youtube.com/watch?v=IcBzsP-fvPo
5 https://www.youtube.com/watch?v=twsV81UFFcE
6 https://www.youtube.com/watch?v=gmi4ah7YAi0

20EC3084 – STATISTICAL SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Generalize the properties of statistical models in the analysis of signals using Stochastic processes	**1,2**	**1,2**
CO2	Differentiate the prominence of various spectral estimation techniques for Achieving higher resolution in the estimation of power spectral density	**1,2**	**3**
CO3	Design and development of optimum filters using classical and adaptive algorithms	**1,2**	**3**
CO4	Design based on Kalman filtering and extended Kalman filtering	**2,4**	**1**

Syllabus:

Review of statistical concepts and signal modeling: Random variables, Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables, Central Limit theorem, Random processes, ergodicity, wide-sense stationary processes, autocorrelation and auto covariance functions, Gaussian Process and White noise process, Autoregressive Moving Average (ARMA) Processes. Signal Modeling: Least Square method, Pade Approximation, Pole-zero and all-pole modeling, the Autocorrelation and covariance method, ARMA models

Optimum Filtering: Linear mean square filtering, Wiener-Hoff Equation, FIR wiener filter, linear prediction and noise cancellation, causal IIR Wiener filter, causal linear prediction, Wiener deconvolution

Spectrum Estimation: Nonparametric methods: Periodogram method and its performance, Bartlett's and Welch's method, Performance comparision. Minimum variance spectrum estimation, maximum entropy method, Parametric methods: ARMA spectrum estimation, Frequency estimation

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking

Text Books

M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 2014

S. M. Kay, Fundamental of Statistical Signal Processing: Estimation Thoery Vol-I PHI-2010

M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

"Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

Jerry M. Mendel, Lessons inEstimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995

Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1985.

Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

Web References

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https://onlinecourses.nptel.ac.in/noc18_ee33/previe

https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

https://www.youtube.com/watch?v=qqeRUgAvmzQ

https://www.youtube.com/watch?v=o1-hj6GKaFY

https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3085 – ADAPTIVE SIGNAL PROCESSING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Comprehend design criteria and modelling adaptive systems and theoretical Performance evaluation	**1,2**	**1,2**
CO2	Design a linear adaptive processor and Kalman filters	**1,2**	**3**
CO3	Apply mathematical models for error performance and stability	**1,2**	**3**
CO4	Comprehend the estimation theory for linear systems and modelling algorithms.	**2,4**	**1**

Syllabus:

Winer Filters: FIR Wiener filters, linear prediction-forward and backward predictions, Levinson-Durbin Algorithm and lattice filter, IIR Wiener filters, non-causal Wiener filter, innovation and causal Wiener filter.
Kalman filters: Gauss-Markov state variable models; innovation and Kalman recursion, steady-state behavior of Kalman filters.

Adaptive filters: steepest descent solution of FIR Wiener filter, LMS algorithm- convergence, steady-state behavior and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation, models.
Advanced Adaptive algorithms: Normalized algorithms, Variable Step Size algorithms, Block based adaptive algorithms, Time domain and frequency domain, convergence analysis.

Text Books

1 S. Haykin, Adaptive Filter Theory, Pearson, 5ed, 2014

2 D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, McGraw Hill, 2000

3 Paula S. R. Diniz, "Adaptive Filtering, Algorithms and Practical Implementation", Third edition, Springer Publishers, 2008.
4 Ali H Syed, John Wiley and Sons, "Adaptive Filters", New Jersey, USA, 2008.

5 Farhang-Boroujeny, B., John Wiley and Sons, "Adaptive Filters-Theory and Applications", Chichester, UK, 1998.

Web References

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

2 https://onlinecourses.nptel.ac.in/noc18_ee33/previe

3 https://drive.google.com/file/d/1lpksgYbRX2kD7LXLk62B-LSnd8tSXz2k/view

4 https://www.youtube.com/watch?v=qqeRUgAvmzQ

5 https://www.youtube.com/watch?v=o1-hj6GKaFY

6 https://www.youtube.com/watch?v=2gI3aC5blfA

20EC3086 – DETECTION AND ESTIMATION OF SIGNALS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Recognizing the fundamentals of Probability and Random Processes	1,2	1,2
CO2	Understanding the statistical decision theory and signal detection processes.	1,2	2
CO3	Explore the estimation theory and their properties	2,4	3
CO4	Analyzing the state estimation techniques	2,4	2

Syllabus:

Review of Probability and Random Processes: Probability, conditional Probability and Bayes' rule, random variables, random data, Generation of Pseudo-random noise, Moments and moment generating functions, distributions, random processes, power spectral density, ergodicity.
Statistical Decision Theory and signal detection: Bayes' criteria, binary and M-ary hypothesis testing, Maximum likelihood , Neyman-Pearson criterion, composite hypothesis testing, sequential detection, energy detector, detection in presence of noise.
Estimation Theory and properties of estimator: Introduction, Generalized likelihood ratio test, MAP and ML estimation, Uniform cost function, Mean Square estimation, Criteria for good estimator, CR inequality, Bayes' estimation, Multiple parameter estimation.
State Estimation: State-space model and the optimal state estimation problem, Prediction, Digital Discrete Kalman Filter, Weiner filter, Stored Data Weiner Filter, Signal Processing examples: Time varying channel estimation, Vehicle tracking.

Text Books

1 Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House Inc, Norwood, MA 02062, 2005.
2 Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall New Jersey, 1993.
3 Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.

Reference Text Books

1 Probability, Random Variables and Random Signal Principles", *Peyton Z.Peebles* Jr, 4th Edition, Tata Mc Graw Hill.

2 Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.

3 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing, with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

4 Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

20EC3087 – BIOMEDICAL SIGNAL ANALYSIS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Basics	**1,2**	**1,2**
CO2	Modalities, Signal Processing Methods	**1,2**	**3**
CO3	Modern Biomedical Technologies & Instruments	**1,2**	**3**
CO4	Advanced Applications	**2,3**	**1,2**

Syllabus:

Basics: Sources of bio-potential, cell structure, activity, resting potential, action potential, propagation of action potentials in nerves; rhythmic excitation of heart, heart activity complexity.

Modalities, Signal Processing Methods: ECG: Pre-processing, wave form recognition, EEG: Evoked responses, averaging techniques, pattern recognition, epilepsy detection. EMG: Wave pattern studies, biofeedback and other potentials. MRI, NMR, Ultra ---------------Sound, CT-Scan, 3D Imaging Techniques.

Modern Biomedical Technologies & Instruments: Robotic Hand-evaluation, functional block diagram, operation; Tissue Diagnostics using Lasers - Diagnostic Applications of Lasers in Ophthalmology and Flow Cytometry; Remote Surgery- methodology, components; Remote Health Care monitoring systems; Health Informatic Systems.

Advanced Applications: Wavelet decomposition of physiological signals for analysis; Wavelets' approach to Heart Rate, Speech, Corona, Brain, Prosthetic; Artifacts in bio-potentials, artifact elimination methods and structures, beamforming in brain analysis.

Text Books

1 Rangaraj M Rangayyan, John Wiley and Sons, "*Biomedical Signal Analysis- A case study approach*", USA, 2ed, 2016.
2 E.N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley and Sons, 2001.
3 Cromwell, Biomedical Instrumentation and Measurements, Pearson, 2015.

4 Ronald W. Waynant, Lasers in Medicine, CRC Press, 2001

5 Edward H Shotliffe, *Biomedical informatics*, Springer, Fourth edition, 2013.

Web References

1 https://www.youtube.com/watch?v=S_U-s27nPLE

2 https://www.sciencedirect.com/topics/engineering/biopotential

3 https://www.ibiology.org/techniques/introduction-to-flow-cytometry/

4 https://www.youtube.com/watch?v=ElZU13meAK4

5 https://www.uni-muenster.de/AMM/num/Vorlesungen/Skiseminar_WS07/talks/Stefanie_Sillekens.pdf

RF & MICROWAVE
20EC3091 – MICROWAVE ENGINEERING

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the various microwave devices.	**1,2**	**1**
CO2	Analysis of scattering parameters of Tee junction and passive components	**1,2**	**1**
CO3	Understand the concept of design of different microwave filters	**1,2**	**1**
CO4	Analyse the applications and advanced topics of microwave	**2,3**	**2**

Syllabus:

Microwave devices: Introduction to microwave Components, Klystron, TWT, Magnetron. Solid state devices: IMPATT, TRAPATT, BARRIT, GUNN and PIN.

Microwave Passive Components and Waveguide Tees: Significance of scattering parameters and formation of S-matrix for n port network. Scattering parameter analysis of E-Plane, H-Plane and Magic Tee. Directional coupler, Isolator, gyrator, circulator. Microwave bends, twists, corners and posts.

Microwave Filters and Periodic structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Microwave Applications: Microwave medical applications, X-ray, Microwave Imaging, and MRI Scanning. Communication Radar applications, Satellite RF Link Applications

Text Books	
1	Microwave devices and circuits- Samuel Y.Liao, Pearson, 3rd edition, 2003.
2	Microwave engineering passive Circuits, Peter A.Rizzi, PHI, 1999.
3	Robert E Collin, "Foundation for Microwave Engineering", McGraw-Hill
Reference Books	
1	Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", McGraw-Hill.
2	"Analysis Methods for RF, Microwave, and Millimetre-Wave Planar Transmission Line Structures", by Cam Nguyun

20EC3092 – ANTENNA DESIGN & WAVE PROPAGATION

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to identify the radiation fields and antenna fundamentals	**1,2**	**BTL**
CO2	Able to Identify different types of antennas and arrays	**1,2**	**1**
CO3	Understand the concept of antenna measurements, design and testing.	**1,2**	**1**
CO4	Study of real-world applications of various antennas.	**5**	**1**

Syllabus:

Radiation concept and antenna fundamentals: Concept of Vector Potential, Radiation of Small Current Element, Radiation of Short Dipole, Radiation from Half-Wave Dipole and its Radiation Resistance & Quarter-Wave Monopole, Antenna Parameters like Radiation Patterns, Directivity, Gain, Radiation Resistance, Polarization, Effective Length and Effective Area and Antenna efficiency

Antenna types and Arrays: Log periodic antenna, Reflector antenna, Lens Antenna, Horn antenna. Two Element Arrays, N- Element Linear Arrays – BSA, EFA, Directivity N-Element Linear Array with Uniform Spacing, Non-Uniform Amplitudes, Binomial Arrays, Principle of Pattern Multiplication.

Antenna Measurement and testing: Introduction, Impedance/VSWR measurements, scattering parameters Types of Ranges: Anechoic Chamber, Elevated Ranges, Slant Range Ground Ranges, Near Field Ranges, CATR, Radiation Pattern Measurements, Gain Measurements

Real world applications of Antennas: Antenna design for mobile applications Antenna design for vehicular applications, Antenna design for satellite applications

Text Books

1 C.A Balanis, “Antenna Theory”, John Wiley & Sons, 2nd ed.
2 E.C. Jordan and K.G. Balamain, “Electromagnetic Waves and Radiating Systems”. 2nd ed., Pearson
3 John D Kraus, “Antennas”. 2nd ed., Mc Graw-Hill
4 S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.

Reference Books

1 3. Evans, Gray E," Antenna Measurements Techniques", Artech House, Inc
2 4. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements, Scientific Atlants, Inc

20EC3093 – RADAR ENGINEERING & NAVIGATIONAL AIDS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the essential principles of operation and design of simple radar systems and analysis of essential elements of Transmitters , Receivers and design of simple Radar Receiver	**1**	**2**
CO2	Understand various types of Radars	**1,2**	**2**
CO3	Understand the principles of various Radars systems used in different applications	**3**	**2**
CO4	Understand the basic concepts related to different systems and sensors for navigation.	**3**	**2**

Syllabus:

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. **Transmitter and Receivers**: RF Power Sources. The Radar Receivers, Receiver Noise Figure, Duplexers and Receiver Protectors, Radar Displays.

Radar types: MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation

MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters. **Tracking:** Sequential Lobing Radar, Conical Scan and Monopulse acquisition and tracking, Radars for Air Traffic Control applications.

Radar Applications:, SAR, LIDAR, OTH radar, Remote sensing radar, Airport surveillance radar, Weather / Meteorological radar, Ground penetration radar, Through-wall radar, Automobile radar.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation **Radio Ranges:** LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Text Books

1 Merrill I Skolnik, “Introduction to Radar Systems”, 3rd Edition, TMH, (2003)
2 William L. Melvin, James A. Scheer, “Principles of Modern Radar”, SciTech Publishing.

3 Elements of Electronic Navigation Systems", Tata McGraw-Hill,

Reference Books

1 Peyton Z Peebles Jr, "Radar Principles", John Wiley Inc., (2004).
2 Donald R Wehner, "High Resolution Radar", Artchtech house.
3 Radar Systems and Radio Aids to Navigation, Sen & Bhattacharya, Khanna publishers
4 J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004.

20EC3094 – MODERN ANTENNAS, MILLIMETER WAVES & APPLICATIONS

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and analysis of modern antenna design	**1**	**2**
CO2	Understand the concepts of mm waves and meteorological applications.	**1,2**	**2**
CO3	Understand and analysis of mm wave circuits.	**3**	**2**
CO4	Study of applications of modern antennas and mm wave radar.	**3**	**2**

Syllabus:

Modern Antennas: Phased array antennas, active phased array antennas, Biomedical antennas, Wearable antennas, Implantable antennas.
Millimeter wave Introduction: EM Spectrum, RF Range, Meteorological applications of MillimeterWaves.
Millimeter wave circuits*:* Microstrip lines, Wave Propagation in microstrip lines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits
Applications of modern antenna, Millimeter wave Radar: Inter-vehicle Communication, Space Communication, Weather Applications, and Meteorological Applications.

Text Books

1 Robert E Collin, "Foundation for Microwave Engineering", Mc Graw-Hill
2 John D Kraus, "Antennas". 2^{nd} ed., Mc Graw-Hill
3 C.A Balanis, "Antenna Theory", John Wiley & Sons, 2^{nd} ed.

Reference Books

1 Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures", by Cam Nguyun.

20EC3095 – ELECTRONIC WARFARE, EMI & EMC

L-T-P-S : 3-0-0-0
Credits ::3
Contact Hours : 3
Pre-requisite : NIL

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concept of Electronic Warfare	**1**	**2**
CO2	Able to identify the different Jamming techniques and its methodologies	**2,3**	**2**
CO3	Understand the concept of design of EMC and components	**2,3**	**2**
CO4	Analyse, design and testing of EMI and EMC	**2,3**	**2**

Syllabus:

Basics of Electronic Warfare: Targets of Electronic Warfare Operations, A General Description of Targets of Electronic Warfare Operations, Electronic Signature, ECM, ECCM, ESM

Methods, Stealth & Applications: Mathematical Models of Signals, Systems and Techniques for Electronic jamming, Active Jamming of Radar, Passive Jamming, False Radar Targets and Decoys, Homing, Stealth Technology.

EMI & EMI Control Techniques:

EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters, EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards.

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal control, Component Selection and mounting

EMC Design Guidelines, EMI Measurement :EMC Design Guidelines Typical Sub systems in Electronic Equipment, Transmitters, Receivers
Antenna Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers. Capacitors, Inductors, Transformers, Resistors, Conductors, Ferrite Beads, Coaxial Connectors, Conductive Gaskets.
EMI Measurements: Radiated Emission Test (OATS, Anechoic chamber) , Immunity Test, ESD, Buist, Surge

Text Books

1 V P Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE

Press,
2 Bernard Kieser, “Principles of Electromagnetic Compatibility”, Artech House 3rd Edition.
3 Henry W. Ott, “Electromagnetic Compatibility Engineering”, A John Wiley & Sons publication.
4 Sergei A. Vakin, Lev N. Shustov, “Fundamentals of electronic warfare”, Artech

Reference Books

1 Clayton R Paul, “Electromagnetic Compatibility”, John Wiley.

2 Tim Williams, “EMC for Product Designer”, Elsevier.

3 PR Chatterton, “Electromagnetic Theory to practical design”, Wiley.

4 Sonia Ben Dhia, “Electromagnetic Compatibility as Integrated Circuits”, Springer.

5 Filippo Neri, “Introduction to Electronic Defense Systems”, Second Edition, Artech.

6 David L. Adamy, “Introduction to Electronic Warfare Modeling and Simulation”, Artech. 7. Richard A. Poisel, “Electronic Warfare Target Location Methods”, Second Edition, Artech.