DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAM DEVELOPMENT DOCUMENT FOR B. TECH (ECE) 2019

Vision of University

To be a globally renowned university.

Mission of University

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 of Department

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

Vision of Department

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 teamwork**: 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 GOALS with MISSION:

Academic Goals	Mission Statements		
	M1	**M2**	**M3**
G1	✓		
G2		✓	
G3		✓	✓
G4	✓		
G5			✓
G6	✓		
G7	✓	✓	✓

Mapping of mission statements with program goals

	Academic Goals						
	G1	**G2**	**G3**	**G4**	**G5**	**G6**	**G7**
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	✓	✓		

B. Tech (ECE) program for the academic year 2019-20 has been framed to be in relevance to APIIC, Human Resource Development Policy, Govt. of India, National Skill Development Corporation, Govt. of India, Confederation of Indian Industries, ABET, NBA norms, O*NET NASSCOM, AP state IT policy and AICTE statutory norms.

As per the recommendations of APIIC number of courses are introduced in the areas of wireless communication, energy-related and verbal and written communication.

As per the recommendations of NSDC Electronics IT hardware numbers of courses are introduced in management courses, basic electronics related, wireless communication, artificial intelligence, bio-medical electronics and automotive electronics related courses are included in the curriculum of ECE.

As per the recommendations of NSDC –IT and ITES number of courses are introduced in the areas of application development, Project management, Testing and quality assurance, Data processing, Web development, UI development, Cloud computing, IoT, MEMS, Signal Processing, and Embedded systems.

As per the recommendations of O*net number of courses are introduced in the areas of VLSI, Wirelss Communications, IOT and Smart cities, Robotics and automation, Data communication, Bio-medical instrumentation, reasoning, and analysis, Team building & communication, Object oriented programming, Matlab programming, Mentor Graphics, Xilinx, software tools, design thinking, English language, Active listening, Critical thinking, Drafting and documentation skills.

As per the recommendations of AICTE number of courses are introduced in the areas of Mathematics, Engineering sciences, Humanities and management courses, English and communication development courses, Professional ethics, Heritage and culture and human values.

As per the recommendations of NASSCOM and AP state software policy number of courses are introduced in the areas of Internet of things, Artificial Intelligence, machine learning, data networking, programming for VLSI, and automated electronics.

Apart from these inputs, all stake holders like recruiting companies, exit feedback from our final year students and parents, alumni feedback and academic peer feedback is also considered while making the final program.

Thus, framed curriculum has been developed through framing of Program Educational Objectives (PEO's) which are mapped to the university Vision and Mission, which are there by disseminated into Program Outcomes (PO's) which thereby have been developed into relevant Course Outcomes (CO's).

Thrust areas of Electronics and Communications Engineering			
LOCAL	REGIONAL	NATIONAL	GLOBAL
APIIC	*NASSCOM*	*NSDC Electronics – IT hardware*	*O*net network Architect*
Wireless communications	IOT	management courses	VLSI
Renewable energies	Machine learning and artificial intelligence	Basic electronics	Wireless Communication
Importance of communication	data networking	Electronics and computer related courses	Bio-medical Instrumentation
	programming for VLSI	Embedded Systems	Data Communication
	Automated electronics		Robotics and automation
AP state software policy		*NSDC –IT and ITES*	*O*net programmer*
IoT		Application development	Python programming
Big data analytics		Project management	Object oriented programming
Machine learning		Testing and quality assurance	Matlab programming
Cloud networking		Data Communications	English language
		IoT	Active listening
		UI development	Critical thinking
		Cloud computing	Drafting skills

		Automation	documentation skills
		Automated Electronics	
		Electronic Instrumentation	
		AICTE	
		Mathematics	
		Engineering sciences	
		Humanities and management courses	
		English and communication development courses	
		Professional ethics Heritage and culture	
https://www.apiic.in/	**https://nasscom.in/knowledge-centre**	**https://nsdcindia.org/**	**https://www.onetonline.org/link/summary/15-1241.00?redir=15-1143.00**

Mapping of needs with Mission:

Local, Regional, National and Global Needs		Mission Statements		
		M1	M2	M3
Local Needs	L9-Electronics HuB	✓		✓
	L10-Aviation &Defense		✓	✓
	L14-Electronics & Information Technology	✓		
	L16-Sensor Technology	✓		✓
	L17-Internet of Things	✓		✓
	L19-Remote Sensing	✓		✓
	L20-Medical Electronics		✓	
	L21-Nano Technology		✓	
Regional Needs	R4-Electronics	✓		✓
	R5-Aviation &Defense	✓	✓	
	R8-Energy		✓	
	R11-IT hardware including bio-medical devices, electronics, and cellular communication	✓	✓	
	R18-Renewable energy and solar parks	✓	✓	
	N10-Electronics Sector	✓		✓
	N11-Nanoscience		✓	
	N13-Security	✓		✓
National Needs	N14-Media and Entertainment	✓		✓
	N15-Electronic and IT Hardware	✓	✓	
	N19-Telecommunication	✓		✓
	N22-VLSI and Semiconductor design	✓	✓	✓
	N23- Consumer Electronics	✓	✓	
	N24- Internet of Things	✓		✓
	N25- Cloud Computing	✓		✓
	N26-Industrial Electronics	✓	✓	
	N27-Automotive Electronics	✓	✓	
	N28-Embedded and Real time systems	✓	✓	✓
	N29-Renewable Energy Sources	✓	✓	✓
Global Needs	G3- New energy supplies and technologies	✓	✓	
	G4- Internet of Things	✓		✓

	G6- Robotics, autonomous transport	✓		
	G7- Artificial intelligence	✓		
	G10- ICT in education	✓		
	G11- Skills development for work	✓		
	G17- Energy	✓	✓	
	G18- Information & Communication technology	✓		
	G20- Nanotechnology		✓	
	G21- Critical thinking			✓
	G22- Machine learning	✓	✓	
	G35- Sensor Networks	✓		
	G36- Embedded System Technology	✓	✓	✓
	G37- Real Time Systems Design	✓	✓	✓
	G38- Remote Sensing	✓		

Courses Introduced in 2020-21 Curriculum as per Local, regional, National and Global Needs:

Local, Regional, National and Global Needs		Courses introduced in 2020-21 curriculum as per identified needs
Local Needs	L9-Electronics HuB	Electronics System Design Workshop
	L10-Aviation &Defense	Automated Vehicles & Avionics
	L14-Electronics & Information Technology	Analog Electronic Circuit Design, IT Workshop
	L16-Sensor Technology	Wireless sensor Networks & IOT Applications
	L17-Internet of Things	Embedded Controllers, IoT Workshop, IoT Specialization
	L19-Remote Sensing	Wireless Sensors Networks & IoT
	L20-Medical Electronics	Biomedical Electronics & IOT for Healthcare
	L21-Nano Technology	Semiconductor Memories & MEMS
Regional Needs	R4-Electronics	Electronics System Design Workshop
	R5-Aviation &Defense	Automated Vehicles & Avionics
	R8-Energy	Electronic Systems for Renewable Energy & Smart Grid
	R11-IT hardware including bio-medical devices, electronics, and cellular communication	Biomedical Electronics & IOT for Healthcare, Electronic Instruments & Biomedical Applications
	R18-Renewable energy and solar parks	Electronic Systems for Renewable Energy & Smart Grid
	N10-Electronics Sector	Analog Electronic Circuit Design
	N11-Nanoscience	Semiconductor Memories & MEMS
	N13-Security	Cyber Security & Blockchain Technology
National Needs	N14-Media and Entertainment	Wireless Communications
	N15-Electronic and IT Hardware	Analog Electronic Circuit Design, IT Workshop, Electronics System Design Workshop
	N19-Telecommunication	Wireless Communications
	N22-VLSI and Semiconductor design	VLSI Design and VLSI Specialization
	N23- Consumer Electronics	Electronics System Design Workshop
	N24- Internet of Things	Embedded Controllers, IoT Workshop, IoT Specialization
	N25- Cloud Computing	Cloud-Computing & Network Security
	N26-Industrial Electronics	Calibrations and Designing Advanced Instruments
	N27-Automotive Electronics	Autonomous Vehicles & Automotive Electronics
	N28-Embedded and Real time systems	Embedded Controllers & Embedded Systems Design
	N29-Renewable Energy Sources	Electronic Systems for Renewable Energy & Smart Grid
Global Needs	G3- New energy supplies and technologies	Electronic Systems for Renewable Energy & Smart Grid
	G4- Internet of Things	Embedded Controllers, IoT Workshop, IoT Specialization
	G6- Robotics, autonomous transport	Autonomous Vehicles & Automotive Electronics
	G7- Artificial intelligence	AI & ANN Tools and Applications
	G18- Information & Communication technology	Wireless communication and Data Communications specialization
	G20- Nanotechnology	Semiconductor Memories & MEMS
	G21- Critical thinking	Aptitude Builder I & II
	G22- Machine learning	AI & ANN Tools and Applications
	G35- Sensor Networks	Wireless Sensors Networks & IoT
	G36- Embedded System Technology	Embedded Controllers & Embedded Systems Design

G37- Real Time Systems Design	Embedded Controllers & Embedded Systems Design		
G38- Remote Sensing	Wireless Sensors Networks & IoT		

Mapping of mission statements with program educational objectives

	Description of PEOs	M1	M2	M3
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.	✓	✓	✓

MAPPING OF POs/PSOs with PEOs:

S No.	Key Components of POs and PSOs	Description of PEO			
		Practice Engineering in a broad range of industrial, societal and real world applications	Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.	Conduct themselves in a responsible, professional, and ethical manner.	Participate as leaders in their fields of expertise and in activities that support service and economic development throughout the world.
		PEO 1	PEO 2	PEO 3	PEO 4
PO1	Engineering knowledge	✓	✓		
PO2	Problem analysis	✓	✓		
PO3	Design/development of solutions	✓	✓		✓
PO4	Conduct investigations of complex problems	✓	✓		✓
PO5	Modern tool usage	✓	✓		
PO6	The engineer and society	✓	✓	✓	✓
PO7	Environment and sustainability	✓			✓
PO8	Ethics	✓		✓	
PO9	Individual and teamwork	✓		✓	✓
PO10	Communication	✓		✓	✓
PO11	Project management and finance	✓	✓		✓
PO12	Life-long learning	✓			✓
PSO1	Engineering knowledge	✓	✓		
PSO2	Problem analysis	✓	✓		

GLOBAL, LOCAL AND REGIONAL NEEDS

Thrust/Focussed areas as per APIIC, Telangana Industrial policy, CII, NSDC, Planning commision,UGC, US O*NET, World Economic Forum, UNESCO.

Local Needs identified as per policy document of APIIC from 2017 to 2022		Regional Needs as per policy documents of APIIC & Telangana Industrial policy upto 2022		National Needs as per policy documents of CII, NSDC, Planning commision,UGC from 2017 to 2022		Global Needs as per policy documents of US O*NET, World Economic Forum, UNESCO from 2017 to 2022	
L1	Pharmaceutical Hub	R1	Agro & Food Processing	N1	Industry Deep Dive: Banking	G1	Mobile internet, cloud technology
L2	Fabrication Hub-Rubber and Fabricated Metal	R2	Life sciences (including pharma, biotechnology and medicalequipment)	N2	Industry Deep Dive: Telecom	G2	Processing power, Big Data
L3	Value added Economic Hub- FTZ/SEZ Zone-Textile, Auto,Aerospace &IT/ITeS	R3	Textile & Apparel	N3	Industry Deep Dive:Manufacturing	G3	New energy supplies and technologies
L4	Aquaculture Hub - Logistics Park	R4	Electronics	N4	Industry Deep Dive: Media, Publishing, and Entertainment	G4	Internet of Things
L5	Manufacturing Hub - Agro, Textile, Metal and Mineral	R5	Aviation &Defense	N5	Bio-Technology	G5	PCT patents, applications
L6	Agricultural Trading Hub – AgroProcessing and Textile	R6	Auto & Auto Components	N6	Material Science	G6	Robotics, autonomous transport
L7	Heavy Industries Hub - Textile and Mineral Products	R7	Petroleum, Chemicals, (including Fertilizers) andPetrochemicals	N7	Industry Deep Dive: Healthcare	G7	Artificial intelligence
L8	Tourism Hub-Temples, Schools and Heritage	R8	Energy	N8	Media &SocialDevelopment	G8	Adv. manufacturing, 3D printing
L9	Electronics HuB	R9	Mineral based industry (e.g.Cement)	N9	clean tech	G9	Adv. materials, biotechnology
L10	Aviation &Defense	R10	Leather	N10	Electronics Sector	G10	ICT in education
L11	Automobile and Auto Components	R11	IT hardware including bio-medical devices, electronics, and cellular communication	N11	Nanoscience	G11	Skills development for work
L12	Robust IT platform	R12	Food processing	N12	Cognitive Science	G12	Global citizenship education
L13	IT based Platform for real time monitoring	R13	Automobiles, tractors and farm equipment	N13	Security	G13	Foresight and research
L14	Electronics & Information Technology	R14	Plastics and polymers	N14	Media and Entertainment	G14	lifelong learning for all

L15	Energy	R15	Fast-moving consumer goods and domestic appliances	N15	Electronic and IT Hardware	G15	creative and responsible global citizens
L16	Sensor Technology	R16	Engineering and capital goods	N16	Pharma and Life Sciences	G16	health through education
L17	Internet of Things	R17	Waste management and green technologies	N17	IT-ITeS Sector	G17	Energy
L18	Software Technology	R18	Renewable energy and solar parks	N18	Tourism, Hospitality and Travel	G18	Information & Communication technology
L19	Remote Sensing			N19	Telecommunication	G19	Active Learning
L20	Medical Electronics			N20	Automotive SkillDevelopment	G20	Nanotechnology
L21	Nano Technology			N21	Security Sector	G21	Critical thinking
				N22	VLSI and Semiconductor design	G22	Machine learning
				N23	Consumer Electronics	G23	Programming
				N24	Internet of Things	G24	Higher education and training
				N25	Cloud Computing	G25	Quality control
				N26	Industrial Electronics	G26	Basic Skills
				N27	Automotive Electronics	G27	FDI and technology transfer
				N28	Embedded and Real time systems	G28	Improving learning process and skills
				N29	Renewable Energy Sources	G29	Building effective partnership for education
						G30	Technological Readiness
						G31	Innovation
						G32	University-industry collaboration in R&D
						G33	Remote Infrastructure management
						G34	Mobile Computing
						G35	Sensor Networks
						G36	Embedded System Technology
						G37	Real Time Systems Design
						G38	Remote Sensing
						G39	Reliable Sources

SNO	COURSE CODE	COURSE NAME	L	T	P	S	Cr	Pre requisites
I		**HUMANITIES & SOCIAL SCIENCES**						
1	19UC1101	BASIC ENGLISH	0	0	4	0	2	NIL
2	19UC1202	ENGLISH PROFICIENCY	0	0	4	0	2	NIL
3	19UC2103	PROFESSIONAL COMMUNICATION SKILLS	0	0	4	0	2	NIL
4	19UC2204	APTITUDE BUILDER-I	0	0	4	0	2	NIL
5	19UC3105	APTITUDE BUILDER-II	0	0	4	0	2	NIL
6	19UC3206	CAMPUS TO CORPORATE	0	0	4	0	2	NIL
7	19UC0009	ECOLOGY & ENVIRONMENT	2	0	0	0	0	NIL
8	19UC0008	INDIAN CONSTITUTION	2	0	0	0	0	NIL
9	19UC0007	INDIAN HERITAGE AND CULTURE	2	0	0	0	0	NIL
10	19UC0010	UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS	2	0	0	0	0	NIL
11	19UC0011	ENTREPRENEURSHIP	2	0	0	0	0	NIL
12	19GN1101	COUNSELLING	0	0	0	4	0	NIL
Total Credits							**12**	
II		**BASIC SCIENCES**						
1	19MT1101	MATHEMATICS FOR COMPUTING	3	1	0	4	5	NIL
2	19MT2102	MATHEMATICS FOR ENGINEERS	3	0	0	0	3	NIL
3	19BT1001	BIOLOGY FOR ENGINEERS	2	0	0	0	2	NIL
		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	19CY1002	CHEMISTRY & BIOINFORMATICS FOR ENGINEERS	3	0	2	0	4	NIL
3	19CY1004	ORGANIC ELECTRONICS	3	0	2	0	4	NIL
Total Credits							**18**	
III		**ENGINEERING SCIENCES**						
1	19SC1101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	3	0	2	0	4	NIL
2	19SC1202	DATA STRUCTURES	3	0	2	3	4.75	NIL
3	19ME1103	DESIGN TOOLS WORKSHOP - I	0	0	4	0	2	NIL
4	19SC1209	DESIGN TOOLS WORKSHOP - II	0	0	4	0	2	NIL
5	19SC1106	TECHNICAL SKILLS-1(CODING)	0	0	0	6	1.5	NIL
6	19SC1203	OBJECT ORIENTED PROGRAMMING	3	0	2	3	4.75	NIL
7	19EC1101	DIGITAL LOGIC & PROCESSORS	3	0	2	0	4	NIL
8	19EC1213	BASIC ELECTONICS CIRCUITS	3	0	0	0	3	NIL
9	19EC2111	ELECTRONIC WORKSHOP-II (ELECTRONIC SYSTEM DESIGN WORKSHOP)	1	0	2	2	2.5	NIL
10	19EC2214	ELECTRONIC WORKSHOP-III (IOT APPLICATIONS)	1	0	0	4	2	NIL

11	19EC2112	IT WORKSHOP-I (HTML,XML,WEB DESIGN)	1	0	2	0	2	NIL

Total Credits							**32.5**	

		PROFESSIONAL CORE COURSES						
1	19EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	2	0	0	0	2	19EC1101
2	19EC2103	ANALOG ELECTRONIC CIRCUIT DESIGN	3	0	2	2	4.5	NIL
3	19EC2104	COMMUNICATION SIGNALS & SYSTEM DESIGN	3	1	0	0	4	NIL
4	19EC2105	ANALOG AND DIGITAL COMMUNICATION	3	0	3	0	4.5	NIL
5	19EC2106	EMBEDDED CONTROLLERS	2	0	3	2	4	NIL
6	19EC2207	ELECTROMAGNETIC FIELDS & APPLICATIONS	3	1	0	0	4	NIL
7	19EC2208	DIGITAL SIGNAL PROCESSING	3	0	2	0	4	NIL
8	19EC2209	STATISTICS, AI & ANN-Basic Course	3	0	0	2	3.5	NIL
9	19EC2210	DATA NETWORKS AND PROTOCOLS	3	0	2	0	4	NIL
10	19EC2223	INTRODUCTION TO AI & ANN TOOLS AND APPLICATIONS	3	0	0	0	3	NIL

Total Credits							**34.5**	

SKILLING COURSES								
1	19TS4001	SKILLING FOR ENGINEERS-1	0	0	0	4	1	NIL
2	19TS4002	SKILLING FOR ENGINEERS-2	0	0	0	4	1	NIL
3	19TS4003	SKILLING FOR ENGINEERS-3	0	0	0	4	1	NIL
4	19TS4004	SKILLING FOR ENGINEERS-4	0	0	0	4	1	NIL
5	19TS4005	TECHNICAL PROFICIENCY & TRAINING- 1	0	0	0	4	1	NIL
6	19TS4006	TECHNICAL PROFICIENCY & TRAINING-2	0	0	0	4	1	NIL

Total Credits							**6**	

TERM PAPER & PROJECT								
1	19IE2246	INDUSTRIAL TRAINING	0	0	4	0	2	NIL
2	19IE3247	TERM PAPER	0	0	4	0	2	NIL
3	19IE4048	PROJECT (PART I)	0	0	0	24	6	NIL
4	19IE4049	PROJECT (PART II)	0	0	0	24	6	NIL
5	19IE4050	PRACTICE SCHOOL	0	0	0	24		NIL
6	19IE4051	INTERNSHIP	0	0	0	24		NIL

Total Credits							**16**	

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
3	OE-3	OPEN ELECTIVE-3	3	0	0	0	3	NIL
4	OE-4	MANAGEMENT ELECTIVE	3	0	0	0	3	NIL
5	OE-5	FOREIGN LANGAUGE ELECTIVE	2	0	0	0	2	NIL

Total Credits							**14**	

		PROFESSIONAL ELECTIVES						
1	PE-1	PROFESSIONAL ELECTIVE-1					3.5	
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							**18.5**	

Grand Total Credits	**163.5**

S.No	Course Code	Course Name	CO No.	Course Outcome	PO												PSO	
					1	2	3	4	5	6	7	8	9	10	11	12	1	2
I				**HUMANITIES & SOCIAL SCIENCES**														
1	19UC1101	BASIC ENGLISH	1	Apply the practical knowledge of using action words in sentence construction.										2				
			2	Apply and analyze the right kind of pronunciation with regards to speech sounds and able to get different types of pronunciations.										2				
			3	Apply the concept of fundamental principle of counting to solve the problems on linear, circular permutations and also for the problems on selections. Apply the concept of probability, while doing the problems on Leap year & Non-Leap year problems, coins, dice, balls and cards.	2													
			4	Analyze the given conditions and finding out all the possible arrangements in linear & circular order. Analyze the given numbers or letters to find out the hidden analogy and apply that analogy to find solutions. Finding the odd man out by observing the principle which makes the others similar.					2									
2	19UC1202	ENGLISH PROFICIENCY	1	Apply the concepts of accurate English while writing and become equally at ease in using good vocabulary and language skills.								2	2	2				
			2	Understand the importance of pronunciation and apply the same day to day conversation.								2	2	2				

S.No	Course Code	Course Name	CO	Course Outcome	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			3	Apply the concepts of ratios, percentages, averages and analyze the given information on the basis of comparative analysis of the data in the form of tabulation, bar graphs, pie charts, line graphs.	2			2												
			4	Apply the basic functionality of clocks and calendars to find the solutions for the problems. Analyze the given symbols to understand the hidden meaning of the given expression and find the solutions. Analyze the possible arrangements in linear & circular order.	2				2											
3	19UC2103	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	2				
			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.										2						
			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.	2															
			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			2												

S.No	Course Code	Course Name	CO	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
4	19UC2204	APTITUDE BUILDER-I	1	Apply the concept of Critical Reading and Analytical Reading and comprehend the key ideas and gist of a passage. Understand the importance of the presentation skills, analyze the given topic, apply various strategies and the principles of grammar in written expression.					2	2									
			2	Apply the concepts of grammar, various strategies and the usage of formal language in written expression. By using synonyms rewrite the same text in the same format and meaning. Write the gist of the given text.							2			2					
			3	Apply the concepts of Numbers to solve the problems related to divisibility rules, problems based on Unit's digit, Remainders, Successive Division, Prime Factorization, LCM & HCF problems. Apply the concepts of Averages & Alligations, students will be able to solve the problems related to Averages as well as problems based on Mixtures.	2				2										
			4	Apply the various concepts of cubes to find out how to cut a cube to get the maximum number of smaller identical pieces, how to minimize the number of cuts required to cut a cube into the given number of smaller identical pieces, how to count the number of smaller cubes which satisfy the given painting scheme. Apply the principles of binary logic to solve problems involving truth-tellers, liars and alternators. Analyze the given data to form an ordered arrangement from an unorganized raw data.	2				2										
5	19UC3105	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.								2		2					

No	Code	Name	CO	Description	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
			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			2												
			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	19UC3206	Campus to Corporate	1	Analyze basic concepts of critical and analytical reasoning skills apply strategies analyze issues, arguments and some aspect of corporate communication.						3	3			3						
			2	Creativity in writing of any given context like sending Emails, Reports, Proposals etc. Make the student to face HR interviews.								4	4		4					
			3	Enable the students to decipher the meaning of the context in the given texts. It also helps students to develop critical thinking.	3		3	3												
			4	Comprehension passages assist in developing writing skills and in grooming them to be ready for placements.	3			3												
6	19UC0007	*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															

S.No	Course Code	Course Name	CO	Course Outcome	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			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																
7	19UC0008	*INDIAN CONSTITUTION	1	To understand Constitutional development after Independence															2		
			2	To learn the fundamental features of the Indian Constitution															2		
			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		
8	19UC0009	*ECOLOGY & ENVIRONMENT	1	Understand the importance of Environmental education and conservation of natural resources.							1										
			2	Understand the importance of ecosystems and biodiversity.															2		
			3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.							1										
			4	Understand the importance of Environmental education and conservation of natural resources.							1										
9	19UC0010	*UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS (ONLINE)	1	Understand and identify the basic aspiration of human beings									1								
			2	Envisage the roadmap to fulfill the basic aspiration of human beings.									1								
			3	Analyze the profession and his role in this existence.									1								

*Note: * marked course are audit courses*

II					BASIC SCIENCES																
1	19MT1101	MATHEMATICS FOR COMPUTING		1	Understand the basic Structures, relations and permutations & combinations, probability	2															
				2	Model and solve the relevant physical problems mathematically as a system of linear equations.	2															
				3	Apply the rules of Propositional logic to establish valid results of mathematical arguments, Induction and solve recurrence relations.	2															
				4	Understand the graphs and analyze different problems associated with computer, logic design.	2															
				5	Describe the Aptitude & Reasoning skills	2															
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								
					SCIENCE ELECTIVE-1																
4	19PH1008			1	Ability to understand classification of solids based on their Energy Bands.	1						1									

#	Code	Course	CO	Outcome																		
		PHYSICS FOR ELECTRONIC ENGINEERS	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												
5	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												

S.No	Course Code	Course Name	CO	Course Outcome	1	2	3	4	5	6	7	8	9	10	11	12	13	14
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	1						1							
6	19PH2101	Quantum Mechanics for Engineers	1	Understand the need of Quantum Mechanics and mathematical formulations of equations.		2												
			2	Understand the Wave function and its Physical properties.		2												
			3	Understand the applications of Quantum Mechanics for some semiconducting components.		2												
			4	Understand some simple Quantum Systems		2												
				SCIENCE ELECTIVE-2														
6	19CY1101	ENGINEERING CHEMISTRY	1	Demonstrate different types of semiconducting materials	1		1										1	1
			2	llustrate photophysical 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
			5	An ability to apply and generate experimental skills		1		1									1	1

#	Code	Course	CO	Statement															
7	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
8	19CY1004	Organic Electronics	1	Demonstrate different types of semiconducting materials	1		1											1	1
			2	Illustrate photophysical 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	19SC1101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	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													

S.No	Course Code	Course Name	CO	Course Outcome	1	2	3	4	5	6	7	8	9	10	11	12	13	14
			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	19SC1202	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	19ME1103	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									

S.No	Course Code	Course Name	CO	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
			4	Visualize and present his design idea by applying AR technique			2												
5	19SC1106	TECHNICAL SKILLS-1(CODING)	1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	2	2												1	
			2	Build solutions for problems on Numbers and array based problems , functions, recursion	2	2												1	
			3	Solve problems solutions for character/string based problems and pointers	2	2												1	
			4	Build solutions to programs on Data structures concepts.	2	2												1	
6	19SC1203	OBJECT ORIENTED PROGRAMMING PM	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	
7	19EC1101	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

S.No	Course Code	Course Name	CO#	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
			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
8	19EC1213	BASIC ELECTONICS 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	19EC2111	ELECTRONIC WORKSHOP-I I (ELECTRONIC SYSTEM DESIGN WORKSHOP)	1	Capable to understand the electronic system design process, analyze the heat management system and understand the soldering techniques.	2				2								2	
			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	19EC2214	ELECTRONIC WORKSHOP-III	1	Understand the fundamentals of IOT components	2		2										2	
			2	Study of sensors, actuators and networks for IOT applications	2		2										2	

S.No	Course Code	Course Name	CO	Course Outcome														
		(IOT WORKSHOP)	3	Analysis and design of electronic systems for IOT	2		2										2	
			4	Development of IOT applications			2											
11	19EC2112	IT WORKSHOP-I (HTML,XML,WEB DESIGN)	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									
12	20UC1101	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				
13	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				
IV		**PROFESSIONAL CORE COURSES**																

S.No	Course Code	Course Name	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	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												
2	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											
3	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

S.No	Course Code	Course Name	CO	Course Outcome															
			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
4	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									
5	19EC2106	EMBEDDED CONTROLLERS	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								
6	19EC2207	ELECTROMAGNETIC FIELDS	1	Understanding the basics of EM fields and magnetic fields	3	1													

S.No	Course Code	Course Name	#	CO Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		& 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													
7	18EC2208	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												
8	19EC2209	STATISTICS, AI, ANN-Basic course	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												
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											
10	19EC2223	INTRODUCTION TO 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													

S.No	Code	Course	CO	Course Outcome	1	2	3	4	5	6
			4	To Implement AI and ANN Models for real time problems	2	2				
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 COMMUNICATIONS	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 behaviour of passive components, Compare Types of Transmission Lines and represent Equivalent Circuits	1	1				

S.No	Course Code	Course Name	CO	Course Outcome													
			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	BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE	1	Study of bio potential recording and different non electric parameter measurements in medical field.	1	2											
			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 automationInstantiating Industrial Automation.		1		1									
			5	Analysing Electronics Instruments			2										
6	19EC3020	SYSTEM ENGINEERING,	1	Introduction to the concepts and techniques of system design	1	2											

		OPERATION RESEARCH & DESIGNING	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 COURSE IN SOFT-COMPUTING (AI, ANN, FUZZY LOGIC & GENETIC ALGORITHMS)	1	Understanding of basic search algorithms	1	1																	
			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 SKILLING COURSES**																					
1	19TS4001	SKILLING FOR ENGINEERS-1	1	Introduction to GSD and LabVIEW Environment such as Front Panel, Controls Palette, Controls and Indicators, Block Diagram Terminals, Functions Palette, Data Type, Boolean Operations, String Operations.	1																		

#	Course Code	Course Name	Unit	Description			
2			2	Introduction to Loop Concept, Nested Loop, Feedback, Arrays, Cluster, Plotting Data using chart and Graph, Tunnel Concept, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes using LabVIEW.		2	
			3	Introduction to Case structures, Case Control using Enumerated data type, Introduction to Flat Sequence, Create New Sub VI, Input and Output Sub VI Connectors, Error handling and Debugging Techniques, Introduction to File I/O operations, Event Structure and operations, Design Technique, Introduction to Architecture, Synchronization and Communication using LabVIEW.		2	
			4	Introduction to Data Acquisition, Introduction to NI myDAQ; Study of simulate signal express VI and verifying Nyquist theorem; Generating waveform signals; Acquiring generated signal; Build and develop Temperature monitoring system			3
2	19TS4002	SKILLING FOR ENGINEERS-2	1	Introduction to GSD and LabVIEW Environment such as Front Panel, Controls Palette, Controls and Indicators, Block Diagram Terminals, Functions Palette, Data Type, Boolean Operations, String Operations.	1		
			2	Introduction to Loop Concept, Nested Loop, Feedback, Arrays, Cluster, Plotting Data using chart and Graph, Tunnel Concept, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes using LabVIEW.		2	
			3	Introduction to Case structures, Case Control using Enumerated data type, Introduction to Flat Sequence, Create New Sub VI, Input and Output Sub VI Connectors, Error handling and Debugging Techniques	2	2	
			4	Introduction to File I/O operations, Event Structure and operations, Design Technique, Introduction to Architecture, Synchronization and Communication using LabVIEW.		2	2
3	19TS4003	SKILLING FOR ENGINEERS-3	1	Learning the Domain based tool and understanding the real time Applications	2		
			2	Understanding the tool for basic operational applications		2	

S.No	Course Code	Course Name	CO	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
			3	Understanding the tool for Minor Projects (Real time applications)		2													
			4	Applying the domain based tool for project developments which can be used as a product.			3												
4	19TS4004	SKILLING FOR ENGINEERS-4	1	Learning the Domain based tool and understanding the real time Applications					3				3	3	1			3	3
			2	Understanding the tool for basic operational applications					3				3	3				3	3
			3	Understanding the tool for Minor Projects (Real time applications)					3				3	3	1			3	3
			4	Applying the domain based tool for project developments which can be used as a product.					3				3	3	1			3	3
5	19TS4005	TECHNICAL PROFICIENCY & TRAINING-1	1	Learning the Domain based tool and understanding the real time Applications	2														
			2	Understanding the tool for basic operational applications		2													
			3	Understanding the tool for Minor Projects (Real time applications)		2													
			4	Applying the domain based tool for project developments which can be used as a product.			3												
6	19TS4006	TECHNICAL PROFICIENCY & TRAINING-2	1	Learning the Domain based tool and understanding the real time Applications					3				3	3	1			3	3
			2	Understanding the tool for basic operational applications					3				3	3	1			3	3
			3	Understanding the tool for Minor Projects (Real time applications)					3				3	3	1			3	3

| | | | 4 | Applying the domain based tool for project developments which can be used as a product. | | | | 3 | | | 3 | 3 | 1 | | 3 | 3 |

VII	LIST OF PROFESSIONAL ELECTIVES															
ESS1	**IORs & Smart Cities**															
1	19EC3051	Wireless sensor Networks & IOT Applications	1	Understanding of wireless sensor network technologies	3	1										
			2	Study of BLE protocols in WSN security and power applications.	1	1										
			3	Study and application of IOT and WSN for smart cities/ villages.	1	1										
			4	Study of various IoT application in various domains		1		1								
2	19EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	1	Understand the basics of solar photo-voltaic cell structure	3	1										
			2	Study of basic physics and components of solar photo voltaic cells	1	1										
			3	Study and design of solar PV systems and testing	1	1										
			4	Analysis and design of SPV arrays		1		1								
3	19EC3053	Electronic Systems for Renewable Energy & Smart Grid	1	Study of Renewable Energy and types with solar power and electronic power converters.	3	1										
			2	Understanding the electronics system for renewable energy sources with different sensors and data management.	1	1										
			3	Understanding the design of smart grid sub system and circuits.	1	1										
			4	Study of Smart grid to IOT applications with smart grid security, communication and power system		1		1								
4	19EC3054	IOT Applications for Smart Cities	1	Understand the basics of smart cities/villages/living	3	1										
			2	Study of systems for smart cities with case studies.	1	1										
			3	Analysis and design of smart grid sub-systems and circuits	1		1									

			4	Study of advanced topics related to privacy, scaling and design considerations.	1	1											
5	19EC3055	Systems for Smart Cities & Smart Villages	1	Understanding the systems and smart systems with local requirements issues and solutions	1	1											
			2	Study of System for smart villages with different modules of smart villages with privacy and security	1	1											
			3	Study of System for smart cities with different management modules of smart cities.	1	1											
			4	Understanding the next generation needs for smart Systems and Smart Global System.	1	1											
ESS2	**VLSI & MICRO - ELECTRONICS**																
1	19EC3061	Low Power VLSI	1	Understand the power dissipation in MOS structure	3	1											
			2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits	1	1	1										
			3	Apply low power techniques for various combinational circuits.	1	1	1										
			4	Design and analysis of low power techniques for memories.	1	1											
2	19EC3062	Algorithms for VLSI Design Automation	1	Understanding of computational and automation tools	1												
			2	Understanding of VLSI layout modeling		1											
			3	Understand and analysis of hardware models	1		1										
			4	Analysis and understanding the FPGA technologies	1		1		1								
3	19EC3063	ASIC and FPGA Chip Design	1	Study and design of combinational and sequential circuits using PLDs and state machines.	3		1										
			2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.			1								1		

No	Course Code	Course Name	CO	Description	1	2	3	4	5	6	7	8	9	10	11	12	13
			3	To study PLD structures and design process. Study of different CPLD and FPGA architectures	1		1										
			4	To understand different physical process.			1									1	
4	19EC3064	VLSI Sub-system Design and Design for Testability	1	Understand the design flow and methodologies of VLSI sub-system	3		1										
			2	Study of memory and array sub systems	1		1										
			3	Analysis of fault tolerant designs	1		1										
			4	Design of testing of VLSI systems	1		1		1								
5	19EC3065	Semiconductor Memories & MEMS	1	Understanding the basics of non-volatile memories	3	1											
			2	Understanding of random access memories	1		1										
			3	Analysis and understanding memory fault modeling and testing	1		1										
			4	Understand the basics of MEMS and applications	1		1										
6	19EC3066	Analog & Digital IC Applications	1	Understanding the basics of non-volatile memories	3		1										
			2	Understanding of random access memories	1		1										
			3	Analysis and understanding memory fault modeling and testing	1	1	1										
			4	Understand the basics of MEMS and applications	1	1	1										
ESS3	**Robotics & Automation**																
1	19EC3071	Control Systems & Introduction to Robotics	1	Understand the concepts of control systems	3	1											
			2	Analysis of control systems in time and frequency domains	1	1											
			3	Understanding the basics of robotics	1	1											
			4	Analysis and understanding of kinetics, dynamics and control of robots.	1	1											
2	19EC3072	Autonomous Vehicles & Automotive Electronics	1	Understanding the basics of autonomous vehicles	3	1											
			2	Understand the principles of sensors and actuators	1	1											
			3	Analysis and understanding of automotive electronic systems	1	1											

S.No	Code	Course	No	Description																				
			4	Study of various miscellaneous topics	1	1																		
3	19EC3073	Advanced Robotics	1	Understanding the fundamentals of robotics	3	1																		
			2	Analysis and understanding the various parameters of robots	1	1																		
			3	Analysis and understanding the mechanisms involved in various robots.	1	1																		
			4	Analysis of various case studies and humanoid applications of robots	1	1																		
4	19EC3074	Computer Vision & Applications	1	Understanding of the fundamental concepts related to multi-dimensional signal processing.	3	1																		
			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																		
			4	Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering.	1	1																		
5	19EC3075	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																		
			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																		

Sno	Course Code	Course Name	CO	CO Description	1	2	3	4	5	6	7	8	9	10	11	12
6	19EC3076	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											
			3	Applications of robots for human safety.	1	1										
			4	Study and understanding the assistive robotic systems.	1	1										
ESS4	**SIGNAL PROCESSING**															
1	19EC3081	Speech Signal Processing	1	Understand the basics of speech signal processing				1								
			2	Understand and applications of various transformation techniques for filter.		1										
			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	19EC3082	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 1D and 2D signal analysis and processing by analysing 2D signals in the frequency domain through the Fourier transform			1	1								
			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								
			5	Applications to real world problems.			1	3								
3	19EC3083		1	Fundamentals of Digital image	1	1										

S.No	Course Code	Course	CO	Description				
		Biomedical Image Analysis	2	Image Enhancement in Spatial and Frequency domain	1	1		
			3	Image Segmentation and Compression	1	1		
			4	Morphological Image Processing and Advanced Topics		1		1
4	19EC4084	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		
			3	Explain and analyze the estimation of signal and spectral analysis	1	1		
			4	Explain the Kalman filters and Apply and evaluate Statistical signal processing concepts to various applications under transform domain.		1		1
5	19EC4085	Adaptive Signal Processing	1	Understand the Basic concepts related to adaptive systems	1	1		
			2	Understand the Searching performance surface-stability and rate of convergence	1	1		
			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
6	19EC4086	Detection and Estimation of Signals	1	Understand the concepts of detection theory and binary decisions.	1	1		
			2	Understand the theory and properties of estimation theory.	1	1		
			3	Understand the state estimation using various techniques.		1		1
			4	Understand and application of statistical estimation of parameters.		1		1
7	19EC4087		1	Basics	1	1		

ESS	#	Course Code	Course Name	Unit	Description					
			Biomedical Signal Analysis	2	Modalities, Signal Processing Methods	1	1			
				3	Modern Biomedical Technologies & Instruments	1	1			
				4	Advanced Applications		1	1		
ESS5	**Wireless Communication**									
	1	19EC3091	Information Theory & Coding	1	Understand the basic concepts of coding methodology	1	1	1	1	1
				2	Understand and evaluate different communication channels.	1	1	1	1	1
				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	19EC3092	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
				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	19EC3093	Satellite Communications	1	Introduction: Basic Concepts of Satellite Communications	1	1	1	1	1
				2	Satellite Link Design	1	1	1	1	1
				3	Multiple Access Techniques	1	1	1	1	1
				4	Satellite Navigation & Global Positioning System	1	1	1	1	1
	4	19EC3094	Optical Communication	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
				3	Evaluate different optical network protocols	1	1	1	1	1
				4	Understand different optical networks	1	1	1	1	1
	5	19EC3095		1	5G New Radio	1	1	1	1	1
				2	Massive MIMO for 5G and Beyond 5G	1	1	1	1	1

					1	2	3	4	5												
		Next Generation Wireless Technologies	3	Millimeter wave Communications	1	1	1	1	1												
			4	Vehicular Communications and other Advanced Topics	1	1	1	1	1												
ESS6	**DATA COMMUNICATION & NETWORKS**																				
1	19EC4051	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	DHCP Theory of Operation, DHCP Architecture, , DHCP			1	1	1												
			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															
2	19EC4052	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												
			3	Understand the concept of Broadband Services			1	1	1												
			4	Analysis of Optical Network and Multimedia concepts	1	1															
3	19EC4053	5G Mobile, Wireless Technologies & IEEE 802 Standards	1	Understand the basic concepts 4G & 5G Technologies	1	1															
			2	Able to Identify different 5G Channels and Networking concepts			1	1	1												
			3	Understand the concept of 5G Evaluation and its Applications			1	1	1												
			4	Analysis of various IEEE standards	1	1															
4	19EC4054	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												

S.No	Course Code	Course Name	CO	Course Outcome	C1	C2	C3	C4	C5
			3	Understand the concept of Cloud-Computing and Security			1	1	1
			4	Analysis of various Network Security issues	1	1			
5	19EC4055	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
			3	Able to Identify different various IMS services			1	1	1
			4	Analysis of various Emerging Tech. of IMS	1	1			
ESS7	**RF, MICROWAVE & RADAR**								
1	19EC4061	Microwave Engineering	1	Able to Differentiate different Microwave components	1	3			
			2	Able to Identify transformers and microwave resonators	1	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	19EC4062	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			
			3	Understand the concept of antenna measurements, design and testing.	1	2			
			4	Study of real-world applications of various antennas.				1	
3	19EC4063	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			

#	Code	Title	CO	Description	1	2	3	4	5
			3	Understand the principles of various Radars systems used in different applications			1		
			4	Understand the basic concepts related to different systems and sensors for navigation.			1		
4	19EC4064	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			
			3	Understand and analysis of mm wave circuits.			1		
			4	Study of applications of modern antennas and mm wave radar.			1		
5	19EC4065	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		
			3	Understand the concept of design of EMC and components		2	1		
			4	Analyse, design and testing of EMI and EMC		2	1		
ESS8	**Data Computing**								
1	19EC4071	Machine Learning	1	Understanding learning systems	1	3			
			2	Analyze unsupervised learning techniques	1	2			
			3	Analyze supervised learning techniques	1	2			
			4	Apply deep learning for real world problems		1		2	
2	19EC4072	Data Sciences & Big-Data	1	Analysis of statistical methods for Big data	1	3			
			2	Understanding big data flat forms for large seal data storage	1	2			
			3	Analyze big data streaming flatforms for past data	1		2		
			4	Applying big data for real world flatforms		1		2	
3	19EC4073	Pattern Recognition	1	Understand basic concepts in pattern recognition	1	3			
			2	Understanding Generative Learning Models	1	2			

S.No	Course Code	Course Name	CO	Course Outcome				
			3	Analyze the structured pattern recognition	1		2	
			4	Apply pattern recognition techniques in practical problems.		1		2
4	19EC4074	Block-Chain & Cyber Security	1	Understanding the major components of block chain	1	3		
			2	Understanding bit coin and cryptocurrency	1	2		
			3	Analyze the cyber security issues	1		2	
			4	Apply block chain technique for various domains		1		2
5	19EC4075	Video Surveillance	1	Understanding of the fundamental concepts related to Video Surveillance.	1	2		
			2	Understanding of the feature extraction, pattern analysis visual geometric modelling.	1	2		
			3	Vehicle Tracking and Recognition, Human activity recognition	1	3		
			4	Applications range from Attribute-based people search, Age estimation from face, Gender recognition from face and body		1		2
ESS9	**Instrumentation & Bio-Medical Electronics**							
1	19EC4081	Automated Vehicles & Avionics	1	Understand the basic components of Automotive Electronics	1	2		
			2	Understand the technology involved in autonomous vehicles	1	3		
			3	Analyse the security and control issues	1	2		
			4	Study of applications of modern instruments in Avionics	1	2		
2	19EC4082	Calibrations and Designing Advanced Instruments	1	Understand the basics of instruments and calibration.	1	2		
			2	Study of generations of instruments.	1	3		
			3	Understanding the calibration process, methods and certification.	1	2		
			4	Design of advanced instruments with precision, accuracy and safety.	1	2		

S.No	Code	Course	CO	Course Outcome																								
3	19EC4083	Biological & Cyber-Physical Systems	1	Understand the cyber physical systems and major constituents.	1	2																					
			2	Understand and study of various types of cyber physical systems.	1	3																					
			3	Study of biological and silicon interfaces.	1	2																					
			4	Study of various case studies and miscellaneous topics.	1	2																					
4	19EC4084	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																					
			3	Interpret the basics of Biomedical Electronics,	1	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																					
			3	Analysis and understanding of automotive electronic systems	1	1																					
			4	Study of various miscellaneous topics	1	1																					

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												
			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										

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	19UC1101	BASIC ENGLISH	2				2					2		1		
2	19UC1202	ENGLISH PROFICIENCY	2		2	2				2	2	2				
3	19UC2103	PROFESSIONAL COMMUNICATION SKILLS	2				2			2	2	2				
4	19UC2204	APTITUDE BUILDER-I	2				2	2	2			2				
5	19UC3105	APTITUDE BUILDER-II	1				2			2		2				
6	19UC3206	Campus to Corporate	3			3	3	3	4	4	3	4				
7	19UC0007	*INDIAN HERITAGE AND CULTURE	1													
8	19UC0008	*INDIAN CONSTITUTION												2		
9	19UC0009	*ECOLOGY & ENVIRONMENT						1						2		

S.No	Code	Course	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
10	19UC0010	*UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS (ONLINE)								1								

*Note: * marked course are audit courses*

II		**BASIC SCIENCES**																
1	19MT1101	MATHEMATICS FOR COMPUTING	2															
2	19MT2102	MATHEMATICS FOR ENGINEERS	2															
3	19BT1001	BIOLOGY FOR ENGINEERS					2	2										
		SCIENCE ELECTIVE-1																
4	19PH1008	PHYSICS FOR ELECTRONIC ENGINEERS	1						1									
5	19 PH1004	SOLID STATE PHYSICS	1						1									
6	19PH2101	Quantum Mechanics for Engineers		2														
		SCIENCE ELECTIVE-2																
7	19CY1101	ENGINEERING CHEMISTRY	1	1	1	1	1	1	1								1	1
8	19CY1002	Chemistry and Bio-Informatics for Engineers	1		1		1	1									1	1
9	19CY1004	Organic Electronics	1	1	1	2	1	1	1								1	1
III		**ENGINEERING SCIENCES**																
1	19SC1101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	1	2		2										1		
2	19SC1202	DATA STRUCTURES	1	1		1											1	1
3	19ME1103	DESIGN TOOLS WORKSHOP - I			2	2	2											
4	19SC1209	DESIGN TOOLS WORKSHOP - II			2	2	2											
5	19SC1106	TECHNICAL SKILLS-1(CODING)	2	2													1	
6	19SC1203	OBJECT ORIENTED PROGRAMMING PM			2		2											1
7	19EC1101	DIGITAL LOGIC & PROCESSORS	2	2			1										1	2
8	19EC1213	BASIC ELECTONICS AND CIRCUITS	2				1										1	
9	19EC2111	ELECTRONIC WORKSHOP-I I (ELECTRONIC SYSTEM DESIGN WORKSHOP)	2		2		2		2						2		2	

#	Code	Course														
10	19EC2214	ELECTRONIC WORKSHOP-III (IOT WORKSHOP)	2		2										2	
11	19EC2112	IT WORKSHOP-I (HTML,XML,WEB DESIGN)				2	2									
12	20UC1101	DESIGN THINKING & INNOVATION -1	2	3	3	3	3				3		3			
13	20UC1203	DESIGN THINKING & INNOVATION -2														
IV		**PROFESSIONAL CORE COURSES**														
1	19EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	1	2	1											
2	19EC2103	ANALOG ELECTRONIC CIRCUIT DESIGN	3		2		2									
3	19EC2104	COMMUNICATION SIGNALS & SYSTEM DESIGN	3	3	2		2		2					2	1	1
4	19EC2105	ANALOG AND DIGITAL COMMUNICATION	1		3		2									
5	19EC2106	EMBEDDED CONTROLLERS	1	2	3		1									
6	19EC2207	ELECTROMAGNETIC FIELDS & APPLICATIONS	3	1												
7	18EC2208	DIGITAL SIGNAL PROCESSING	1	2	3											
8	19EC2209	STATISTICS, AI, ANN-Basic course	3	3	2											
9	19EC2210	DATA NETWORKS AND PROTOCOLS	1	2			1									
10	19EC2223	INTRODUCTION TO AI, ANN TOOLS & APPLICATIONS	2	2												
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	1	2	2									
5	19EC3019	ELECTRONICS INSTRUMENTS & AUTOMATION	3	1	2	1										
6	19EC3020	SYSTEM ENGINEERING, OPERATION RESEARCH & DESIGNING	1	2												
7	19EC3021	ELECTRICAL TECHNOLOGIES & SOLAR POWER SYSTEMS	1	2	3	2										

No	Code	Course	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
8	19EC3022	ADVANCE COURSE IN SOFT-COMPUTING (AI, ANN, FUZZY LOGIC & GENETIC ALGORITHMS)	1	3	2	3										
VI		**SKILLING COURSES**														
1	19TS4001	SKILLING FOR ENGINEERS-1	1	2	3											
2	19TS4002	SKILLING FOR ENGINEERS-2	1	2	2											
3	19TS4003	SKILLING FOR ENGINEERS-3	2	2	3											
4	19TS4004	SKILLING FOR ENGINEERS-4					3					3	1		3	3
5	19TS4005	TECHNICAL PROFICIENCY & TRAINING- 1	2	2	2	3										
6	19TS4006	TECHNICAL PROFICIENCY & TRAINING-2					3					3	1		3	3
VII		**LIST OF PROFESSIONAL ELECTIVES**														
ESS1		**IORs & Smart Cities**														
1	19EC3051	Wireless sensor Networks & IOT Applications	3	1		1										
2	19EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	3	1		1										
3	19EC3053	Electronic Systems for Renewable Energy & Smart Grid	3	1		1										
4	19EC3054	IOT Applications for Smart Cities	3	1	1											
5	19EC3055	Systems for Smart Cities & Smart Villages	1	1												
ESS2		**VLSI & MICRO - ELECTRONICS**														
1	19EC3061	Low Power VLSI	3	1	1											
2	19EC3062	Algorithms for VLSI Design Automation	1	1	1			1								
3	19EC3063	ASIC and FPGA Chip Design	3		1									1		
4	19EC3064	VLSI Sub-system Design and Design for Testability	3	1	1		1									

	Code	Course					
5	19EC3065	Semiconductor Memories & MEMS	3	1	1		
6	19EC3066	Analog & Digital IC Applications	3	1	1		
ESS3	**Robotics & Automation**						
1	19EC3071	Control Systems & Introduction to Robotics	3	1			
2	19EC3072	Autonomous Vehicles & Automotive Electronics	3	1			
3	19EC3073	Advanced Robotics	3	1			
4	19EC3074	Computer Vision & Applications	3	1			
5	19EC3075	Human Machine Interface & Brain Machine Interface	3	1			
6	19EC3076	Designing Automation Systems & Assistive Robotic Systems	3	1			
ESS4	**SIGNAL PROCESSING**						
1	19EC3081	Speech Signal Processing		1			1
2	19EC3082	Digital Image Processing			3		1
3	19EC3083	Biomedical Image Analysis	1	1		1	
4	19EC4084	Statistical Signal Processing	1	1		1	
5	19EC4085	Adaptive Signal Processing	1	1		1	
6	19EC4086	Detection and Estimation of Signals	1	1		1	
7	19EC4087	Biomedical Signal Analysis	1	1		1	
ESS5	**Wireless Communication**						
1	19EC3091	Information Theory & Coding	1	1	1	1	1
2	19EC3092	4G Wireless Technologies and Cellular Communication	1	1	1	1	1
3	19EC3093	Satellite Communications	1	1	1	1	1
4	19EC3094	Optical Communication	1	1	1	1	1
5	19EC3095	Next Generation Wireless Technologies	1	1	1	1	1
ESS6	**DATA COMMUNICATION & NETWORKS**						
1	19EC4051	TCP/IP & Other Protocol Suite	1	1	1	1	1
2	19EC4052	VoIP Systems & Broad Band Networks	1	1	1	1	1

	Code	Title					
3	19EC4053	5G Mobile, Wireless Technologies & IEEE 802 Standards	1	1	1	1	1
4	19EC4054	Cloud-Computing & Network Security	1	1	1	1	1
5	19EC4055	IP Multimedia Sub-System & Emerging Technologies (Cloud, IOT, NFV, SDN)	1	1	1	1	1
ESS7	**RF, MICROWAVE & RADAR**						
1	19EC4061	Microwave Engineering	1	3	1		
2	19EC4062	Antenna Design & Wave Propagation	1	3			1
3	19EC4063	Radar Engineering & Navigational Aids	1	3	1		
4	19EC4064	Modern Antennas, Millimeter Waves & Applications	1	3	1		
5	19EC4065	Electronic Warfare, EMI & EMC	1	3	1		
ESS8	**Data Computing**						
1	19EC4071	Machine Learning	1	3		2	
2	19EC4072	Data Sciences & Big-Data	1	3	2	2	
3	19EC4073	Pattern Recognition	1	3	2	2	
4	19EC4074	Block-Chain & Cyber Security	1	3	2	2	
5	19EC4075	Video Surveillance	1	2		2	
ESS9	**Instrumentation & Bio-Medical Electronics**						
1	19EC4081	Automated Vehicles & Avionics	1	3			
2	19EC4082	Calibrations and Designing Advanced Instruments	1	3			
3	19EC4083	Biological & Cyber-Physical Systems	1	3			
4	19EC4084	Electronic Instruments & Biomedical Applications	1	3		2	
5	20EC3072	Autonomous Vehicles & Automotive Electronics	3	1			
6	20EC3075	Human Machine Interface & Brain Machine Interface	3	1		2	

Basic English

Course code : 19UC1101	L-T-P-S : 0-0-4-0
Pre-requisite : NIL	Credits : 2

Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the practical knowledge of using action words in sentence construction.	PO10	2
CO2	Apply and analyze the right kind of pronunciation with regards to speech sounds and able to get different types of pronunciations.	PO10	2
CO3	Apply the concept of fundamental principle of counting to solve the problems on linear, circular permutations and also for the problems on selections. Apply the concept of probability, while doing the problems on Leap year & Non-Leap year problems, coins, dice, balls and cards.	PO1	2
CO4	Analyze the given conditions and finding out all the possible arrangements in linear & circular order. Analyze the given numbers or letters to find out the hidden analogy and apply that analogy to find solutions. Finding the odd man out by observing the principle which makes the others similar.	PO5	2

Gist: Interactive Grammar, Introduction to the Sounds of English, Language Laboratory Interactive, Quantitative Aptitude, Reasoning.

Syllabus:

Interactive Grammar: Action Words-Modifiers, Intensifiers, Connectives - 5 Passages- 5 Worksheets (Revision tests of Bridge Course topics) –Parsing.
Sentence Skills: Tense, Voice, Case, Gender, Reported Speech, Syntax, Types of Sentences, Syntactic Ordering.

Introduction to the Sounds of English: Basic English Sounds, Distinctive Sounds of English, Assimilation, Contraction, Elision, Twinning, Stress, Syllables, Word- stress, Tone and Intonation- Rising, Falling, Rise-fall and Fall-rise.

Language Laboratory Interactive: Esca talk, JAM, Ranking, Shrinking Story, Desperate Decision, Listening for Specifics, Pronunciation Practice

Quantitative Aptitude: Permutations and Combinations, Probability

Reasoning: Number and Letter Analogy, Odd Man out, Analytical Reasoning-I

Reference Books:
1. Kerry Patterson, Joseph Grenny, Ron McMillan:*Crucial Conversations: Tools for Talking When Stakes Are High.*Switzler: Paperback – Animated, September 9, 2011.
2. Douglas Stone, Bruce Patton, Sheila Heen, and Roger Fisher :*Difficult Conversations: How to Have Conversations that Matter the Most* .Paperback – November 2, 2010
3. R.K. Bansal, J.B. Harrison: *Spoken English*. Delhi: Orient Black Swan.2009.

English Proficiency

Course code	: 19UC1202	L-T-P-S	: 0-0-4-0
Pre-requisite	: NIL	Credits	: 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concepts of accurate English while writing and become equally at ease in using good vocabulary and language skills.	PO8, PO9, PO10	2
CO2	Understand the importance of pronunciation and apply the same day to day conversation.	PO8, PO9, PO10	2
CO3	Apply the concepts of ratios, percentages, averages and analyze the given information on the basis of comparative analysis of the data in the form of tabulation, bar graphs, pie charts, line graphs.	PO1, PO4	2
CO4	Apply the basic functionality of clocks and calendars to find the solutions for the problems. Analyze the given symbols to understand the hidden meaning of the given expression and find the solutions. Analyze the possible arrangements in linear & circular order.	PO1, PO5	2

Writing Skills, Advanced Grammar Skills, Language Laboratory Interactive, Quantitative Aptitude, Reasoning

Syllabus:

Writing Skills: How to Write a Definition, Defining Technical Terms, Product and Process Description.

Advanced Grammar Skills: Transformation of Sentences, Phrases, Clauses, Sentences Simple, Compound, Complex Sentences, Concord, Lexis 1:Synonyms, Antonyms, Analogies, Sentence Equivalence-One-Word Substitutes.

Language Laboratory Interactive: Debate, Blind-fold, Role Play, Situation Reaction Test--Build an Island nation.

Quantitative Aptitude: Data Interpretation, Data Sufficiency.

Reasoning: Symbols and Notations, Clocks and Calendars, Analytical Reasoning-II

Reference Books:
1. Dictionary of Technical Terms
2. Dr. Meenakshi Raman and Dr. SangeethaSarma: *Technical Communication*.Oxford University Press: Delhi.2016.
3. The Ultimate Verbal and Vocabulary Builder. Texas: Lighthouse Review.2000.
4. Rajeev Vasisth: *Interactive Vocabulary Drills*. New Delhi: Arihant Publications Limited. 2011.
5. Language LaboratoryTeacher Manual, KLEF

PROFESSIONAL COMMUNICATION SKILLS

Course code	: 19UC2103	L-T-P-S	: 0-0-4-0
Pre-requisite	: NIL	Credits	: 2

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	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.	PO9, PO10	2
CO2	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.	PO8	2
CO3	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.	PO1	2
CO4	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.	PO1, PO5	2

Grammar and Usage, Writing Skills, Reading Comprehension, Tests (RPT), Soft Skills, Cultural Sensitivity in the Workplace, Corporate Culture, Quantitative Aptitude, Reasoning

Syllabus:

Grammar and Usage: Error Analysis.

Writing Skills: Topic sentence, Linkers, Connectors and Transition, Paragraph Writing, Letter Writing

Reading Comprehension: Techniques, Skimming and Scanning, Vertical Reading, Reading Perception Tests (RPT): (Graphic) Reading Perception Tests (RPT), Semantic Interpretation of the Text, Reading Speed Enhancement.

Soft Skills: Interpersonal Skills, Adjusting Your Attitude-Arrogance has no Place in the Workplace, Cultural Sensitivity in the Workplace, Corporate Culture: Learning How to Fit In.

Quantitative Aptitude: Time and Work, Time and Distance

Reasoning: Deductions, Logical Connectives, Venn Diagrams

Reference Books:

1. Gajendra Singh Chauhan and SmitaKashiramka. *Technical Communication.* Delhi:Cengage Learning India.2018.
2. Andrea Penruddocke and Christopher A. Warnasch.English for the Real World.USA:Living Language.2004
3. GeraldJ Alfred, Charles T Brusaw and Walter E.Oliu. Hand Book of Technical Writing. USA:Betford.2000.

APTITUDE BUILDER –I(PROFESSIONAL ATTITUDE & ETIQUETTES)

| Course code | : 19UC2204 | L-T-P-S | : 0-0-4-0 |
| Pre-requisite | : NIL | Credits | : 2 |

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concept of Critical Reading and Analytical Reading and comprehend the key ideas and gist of a passage. Understand the importance of the presentation skills, analyze the given topic, apply various strategies and the principles of grammar in written expression.	PO5, PO6	2
CO2	Apply the concepts of grammar, various strategies and the usage of formal language in written expression. By using synonyms rewrite the same text in the same format and meaning. Write the gist of the given text.	PO7, PO10	2
CO3	Apply the concepts of Numbers to solve the problems related to divisibility rules, problems based on Unit's digit, Remainders, Successive Division, Prime Factorization, LCM & HCF problems. Apply the concepts of Averages &Alligations, students will be able to solve the problems related to Averages as well as problems based on Mixtures.	PO1, PO5	2
CO4	Apply the various concepts of cubes to find out how to cut a cube to get the maximum number of smaller identical pieces, how to minimize the number of cuts required to cut a cube into the given number of smaller identical pieces, how to count the number of smaller cubes which satisfy the given painting scheme. Apply the principles of binary logic to solve problems involving truth-tellers, liars and alternators. Analyze the given data to form an ordered arrangement from an unorganized raw data.	PO1, PO5	2

Directed Listening and Thinking Activity (DLTA) Skills Body Language (Kinesics), Quantitative Aptitude, Reasoning

Syllabus:
Directed Listening and Thinking Activity (DLTA) Skills: Reading, Listening, Thinking, Writing, Presentation - Method: Flipped Classroom.
Writing Skills**:** Paraphrasing, Summarizing, Notice, Circular, Agenda, Minutes, Memo
Body Language (Kinesics): Postures, gestures, eye contact
Self-confidence: Self-esteem
Soft Skills: The Art of Compromise, Learn to Say: "I Don't Know", Being organized, Showing Self-awareness, An eye on success, being self-motivated, Showing self-awareness, Find Direction from Someone Who Is Lost: "The Drifter"
Self-Assessment for Attainable Career Objectives--Defining a Career Objective
Quantitative Aptitude: Numbers, Averages and Alligations, Mensuration
Reasoning: Cubes, Binary Logic, Ordering and Sequencing
Reference Books:

1. Daniel G.Riordan and Steven E. Pauley: *Technical Report Writing Today.* New Delhi*:* Biztantra.2004.
2. Ken Taylor.Telephoning and Teleconferencing Skills. Hyderabad:Orient Black Swan.2008.
3. E. Suresh Kumar, B. Sandhya.Communication for Professional Success. Delhi: Orient Black Swan.2013
4. Reasoning Trainer Plus.:Hyderabad: Brain Mapping Academy.2012

APTITUDE BUILDER-II (VERBAL & QUANTITATIVE REASONING)

Course code   :19UC3105   L-T-P-S   : 0-0-4-0
Pre-requisite   : NIL   Credits   : 2

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	2
CO2	Analyze the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.	PO8, PO10	2
CO3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest	PO1, PO5	2
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	1

Critical Reading, Writing Skills, Trinity Guild Hall, Quantitative Aptitude, Reasoning

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

CAMPUS TO CORPORATE

| Course code | : 19UC3206 | L-T-P-S | : 0-0-4-0 |
| Pre-requisite | : NIL | Credits | : 2 |

Mapping of Course outcomes with Program Outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyze basic concepts of critical and analytical reasoning skills apply strategies analyze issues, arguments and some aspect of corporate communication.	PO5,PO6,PO9	3
CO2	Creativity in writing of any given context like sending Emails, Reports, Proposals etc. Make the student to face HR interviews.	PO7,PO8,PO10	4
CO3	Enable the students to decipher the meaning of the context in the given texts. It also helps students to develop critical thinking.	PO1,PO4,PO5	3
CO4	Comprehension passages assist in developing writing skills and in grooming them to be ready for placements.	PO1,PO5	3

Syllabus: *600 Word list (continue assessment),* Idiomatic Expressions, One word substitutions, Sentence Completion, Reading Comprehension , Time Management, Stress Management, Problem Solving, Situation Reaction, Grooming, Mock Interviews.

Language Laboratory Interactive: Online practice test, Time Management Matrix, Interactive Problem Solving, Designing Tasks for the Communicative Classroom, classroom activity, mock interviews.

Reference Books:

1. KenTaylor.Telephoning andTeleconferencingSkills. Hyderabad: OrientBlackSwan.2008.
2. E.SureshKumar,B.Sandhya.CommunicationforProfessionalSuccess.Delhi:OrientBlackSwan.2013
3. JudithVerify:SucceedingatInterview.Mumbai:VivaBooksPrivateLimited.2000
4. NormanL.Frigon, Sr. &HarryK.Jackson, Jr.TheLeader-DevelopingtheSkillsandPersonalQualities.Mumbai:MagnaPublishingCoLtd.2000.

INDIAN HERITAGE AND CULTURE

Course code	: 19UC0007	L-T-P-S	: 2-0-0-0
Pre-requisite	: NIL	Credits	: 0

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

Introduction-Concept of Culture-Culture and Civilization, History and Culture through the Ages, Advent of Islam in India, Rise of the West and its impact on India.

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

INDIAN CONSTITUTION

Course code	: 19UC0008	L-T-P-S	: 2-0-0-0
Pre-requisite	: NIL	Credits	: 0

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

Making of the Constitution, Basic features of the Indian Constitution, Government of the Union, Government of the State, the Indian Judicial System, Election Commission

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 – the role 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 Court's – 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.

ECOLOGY AND ENVIRONMENT

Course code   : 19UC0009   L-T-P-S   : 2-0-0-0
Pre-requisite   : NIL   Credits   : 0

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	2
CO3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	PO6	1
CO4	Understand the importance of Environmental education and conservation of natural resources.	PO6	1

The Multidisciplinary nature of Environmental Studies, Water resources, Soil waste management, Disaster management

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

Text Books:
   1. AnubhaKaushik, C.P.Kaushik, "Environmental Studies", New Age International, (2007).
Benny Joseph, "Environmental Studies", Tata McGraw-Hill companies, New Delhi, (2009).

UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS

Course code   : 19UC0010   L-T-P-S   : 2-0-0-0
Pre-requisite : NIL   Credits   : 0

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and identify the basic aspiration of human beings	PO8	1
CO2	Envisage the roadmap to fulfill the basic aspiration of human beings.	PO8	1
CO3	Analyze the profession and his role in this existence.	PO8	1

Introduction to Value Education, Harmony in the Human Being, Harmony in the Family and Society, Harmony in the Nature (Existence) , Implications of the Right Understanding – a Look at Professional Ethics

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.

BASIC SCIENCES

MATHEMATICS FOR COMPUTING

Course code	: 19MT1101		L-T-P-S	: 3-1-0-4
Pre-requisite	: NIL		Credits	: 5

Course Outcomes (CO):

CO No:	Course out come	PO	BTL
1	Understand the basic Structures, relations and permutations & combinations, probability	1	2
2	Model and solve the relevant physical problems mathematically as a system of linear equations.	1	2
3	Apply the rules of Propositional logic to establish valid results of mathematical arguments, Induction and solve recurrence relations.	1	2
4	Understand the graphs and analyze different problems associated with computer, logic design.	1	2
5	Describe the Aptitude & Reasoning skills	1	2

SYLLABUS:

Basic Structures: Sets, Functions, Sequences and Summations, Cardinality of Sets, Relations and their Properties, Equivalence Relations. [6 Hours]

Permutations and combinations, Probability: Linear Permutation, Circular Permutation, Addition theorem, Conditional Probability, Multiplication Theorem. [6 Hours]

Matrix Algebra: Introduction, Types of Matrices, Rank of matrix, Solutions of linear equations- Gauss elimination, Jacobi and Gauss Seidel, Eigen values, Eigen vectors. [8 Hours]

Game Theory: Pay of Matrix, Mini-Max criteria, Saddle points, Optimal Strategy, Mixed Strategy, Value of a game [3 Hours]

The Foundations: Logic and Proofs: Propositional Logic, Applications of Propositional, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference [5 Hours]

Applications of Number theory: Fermat's theorem, Euclidean Algorithm [1 Hours]

Counting Techniques: Recursive definitions, Solving Linear Recurrence Relations, Fibonacci series, Divide-and-Conquer Algorithms, Generating Functions, Inclusion–Exclusion [3 Hours]

Lattices: Introduction, Properties of Lattices, Sublattices, Partial order relation, Homomorphism and Isomorphism, Hasse diagrams. [3 hours]

Graphs & Trees: Terminology, Types of Graphs, Bipartite graphs, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path, Planar Graphs [6 Hours]

Statistics: Curve fitting, Correlation, Linear Regression [6 Hours]

Skilling:

LOGIC AND REASONING: Deductions, Logical Connectives, Linear and circular arrangements, Ordering and sequencing, Clocks, Calendars, Blood Relations, Cubes, Direction sense, Number and letter series, Number and letter Analogy, Odd man out, Coding and Decoding, Symbolic representations of given data, Binary Logic, Non Verbal reasoning.(20hrs)

Foundations in Arithmetic : Numbers, Ratio, Proportion, Variation, Averages, Percentages, Profit & loss, Time & Distance, Time & Work.(5hours)

Geometry: Lines, Triangles, Quadrilaterals, Polygons, Practical applications of common solids, irregular solids and their application in various engineering problems(5 hours)

Text books:
1. Basic Engineering Mathematics**,** John Bird, sixth Edition, Elsevier, ISBN:978-1-1380-5382-3
2. Kenneth, K. R., Discrete Mathematics and its Applications, 7thEd.,Tata McGraw Hill

Reference Books:
1. Probability and Statistics for engineers and scientist, R.E.Walpole, R.H.Myers, S.L.Myes,K.E.Je, Pearson learning
2. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd

3. Tremblay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill.
4. A Modern Approach to Verbal and Non-verbal Reasoning, R. S. Agarwal, Schand Publications.

MATHEMATICS FOR ENGINEERS

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

Course Outcomes (CO):

CO No:	Course out come	PO	BTL
1	Apply differential and integral calculus to find maxima & minima of functions and evaluate the integrals	1	2
2	Model and solve the relevant phenomena as a differential equation .	1	2
3	Demonstrate Fourier series and Analytic functions	1	2
4	Describe probability , Random Variables and Algebraic structures	1	2

SYLLABUS :
Calculus:
Differential and Integral calculus: Taylors series for function of variables, Maxima and Minima for functions of two variables, Evaluation of double integrals – Change of order of Integration, Change of Variables, Polar coordinates. [5 hours]
Vector calculus: Scalar and vector point functions, Gradient, Directional Derivative, Divergence and Curl, Evaluation of line integrals – Greens theorem. [5 hours]
Ordinary Differential Equations: Solution of first order equations and their applications- Newton law of cooling, Growth and decay, Solution of Second Order Differential equations. [4 hours]
Partial Differential Equations: Formation of PDE, Solution of first order linear equations – Lagrange's method, Solution of second order PDE by separation of variables. [4 hours]
Laplace Transforms: Laplace and Inverse Laplace transforms and their properties. [5 hours]
Fourier Series: Definition, Dirichlet conditions, Fourier series for simple functions [4 hours]
Complex Variables: Complex functions- Exponential, Logarithmic and Trigonometric functions, Analytic function – Cauchy - Riemann equations - Milne Thomson method [6 hours]
Probability and Random Variables: Probability –Addition, Multiplication and Bayes' theorem. Random variables – Probability distributions – Binomial, Poisson and Gaussian distributions, Markov process. [9 hours]
Algebraic Structures: Structure of Algebras, Semi groups, Monoids and Groups, Homomorphism's, Normal subgroups and congruence Relations, Rings [4 hours]

Text books:
1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Willey& Sons, Inc, Newyork

Reference Books:
1. Probability and Statistics for engineers and scientist, R.E.Walpole, R.H.Myers, S.L.Myes,K.E.Je, Pearson learning
2. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd
3. Tremblay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill.

BIOLOGY FOR ENGINEERS

Course code	: 19BT1001	L-T-P-S	: 2-0-0-0
Pre-requisite	: NIL	Credits	: 2

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

Basic Biology, Systems of Life, Diet and Nutrition, Micro-organisms, Biosensors

Syllabus:

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

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination 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 effects of Bacteria, Fungi and Viruses.

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

Text Books:
1. Dr RC Dubey ,"Advanced Biotechnology", S Chand Publications.
2. P K Gupta ,"Elements of Biotechnology", RASTOGI Publications.

PHYSICS FOR ELECTRONIC ENGINEERS

Course code	:**19PH1008**	L-T-P-S	: 3-0-2-0
Pre-requisite	: NIL	Credits	: 4

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcome (CO)	PO	BTL
CO1	Ability to understand classification of solids based on their Energy Bands.	1,7	1
CO2	Ability to understand the conducting and semiconducting properties of solids at the microscopic level.	1,7	1
CO3	Ability to understand the dielectric properties of materials at the microscopic level and their applications.	1,7	1
CO4	Ability to understand the magnetic interactions in materials and the applications.	7	1

| CO5 (Only for lab components) | Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects | 7 | 3 |

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.

SOLID STATE PHYSICS

Course code   :**19PH1004**   L-T-P-S   : 3-0-2-0
Pre-requisite   : NIL   Credits   : 4

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcome (CO)	PO	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.	1,7	1
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.	1,7	1
CO3	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	1,7	1
CO4	Understands the role of electronic energy band structures of solids using various models, classification of materials	1,7	1

	based on their band structures and their properties		
CO5 (Only for lab components)	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	1,7	3

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.

QUANTUM MECHANICS FOR ENGINEERS

Course Code: 19PH2101   **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL   **Credits: 5**

CO No:	Course Outcome	PO	BTL
1	Understand the need of Quantum Mechanics and mathematical formulations of equations.	2	**2**
2	Understand the Wave function and its Physical properties.	2	**2**
3	Understand the applications of Quantum Mechanics for some semiconducting components.	2	**2**
4	Understand some simple Quantum Systems	2	**2**
5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	7	**2**

Syllabus:

Introduction and Review: Inadequacy of classical physics, Quantum postulates, Black body 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 Tunneling: Potential barrier, tunneling, tunneling probability; Double rectangular barrier, resonant tunneling, 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

ENGINEERING CHEMISTRY

Course Code: 19CY1001   **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL   **Credits: 5**

CO No:	COURSE OUT COME	PO	BTL
1	Predict potential complications from combining various chemicals or metals in an engineering setting	1,3	1
2	Discuss fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena	1,3	1
3	Examine water quality and select appropriate purification technique for intended problem	5,7	1
4	Apply polymers, conducting polymers ,green chemistry and nano chemistry to engineering processes	5,6,7	1
5	An ability to analyze & generate experimental skills	2,4	1

Energy and Chemistry: Energy use and the world economy, defining energy, energy transformation, and conservation of energy, heat capacity, calorimetry, enthalpy, Hess's law and heats of reaction, energy and stoichiometry. **Electro Chemistry***:* 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. **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 reaction, rate laws and the concentration dependence of rates, integrated rate laws, temperature and kinetics, rate mechanisms, catalysis, insight into troposphere ozone. **Molecules and materials-** Types of polymerization-Plastics – Thermoplastic resins and Thermosetting resins - Compounding of plastics – Fabrication of plastics. Preparation, properties and engineering applications of: polyethylene, PVC, Teflon,

Bakelite, Urea Formaldehyde. **Conducting Polymers**: Polyacetylene, polyaniline, conduction, doping and applications. Carbon nanotubes 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, Dr 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.

Chemistry and Bio-Informatics for Engineers

Course Code: 19CY1002   **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL   **Credits: 5**

CO No:	COURSE OUT COME	PO	BTL
1	Develop the current knowledge of materials and apply the characteristics, theories of materials in biomedical applications.	1,5,6	1
2	Interpret the interaction of biomolecules with various bioelectrodes and host responses to implants, including toxicity and health implications	1,5,6	1
3	Relate genetics and modern DNA technology for disease diagnostics, therapy and drug design.	1,5,6	1
4	Illustrate the application of chemistry, organic electronics in diagnostic and therapeutic area.	1,5,6	1
5	Analyse the properties of the samples using analytical instruments which are useful for clinical analysis in health care, drugs and pharmaceutical laboratories.	1,3,6	1

Biomaterials and Semiconductors Introduction to Biomaterials - classification of Biomaterials – polymers - Polymerization – conducting polymers- types – mechanism – applications. Ceramics – Introduction – types- applications. Nanomaterials- Introduction- classification- synthesis- mechanism-properties- applications Semiconductors- organic and inorganic semiconductors – electrochemistry of organic electronic materials – dye sensitized solar cells – organic light emitting diodes – quantum dot LEDs - concept of exciton. CO 2: 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. Concepts of Biopotential- Bioelectrodes- Biosensors- Advantages-limitations and various components of biosensors- Transducers in biosensors- colorimetric- optical-amperometric- piezoelectric- Introduction to actuators- Examples. CO 3: 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. CO 4: 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.

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
6. Biosensors- Fundamentals and Applications, 2nd Edition, DE GRUYTER
7. Biomedical Instrumentation and Measurements, 2nd Edition, Pearson publications
8. Fundamentals and Applications of Organic Electrochemistry: Synthesis, Materials, Devices
9. Engineering chemistry, Jain and Jain
10. Organic Electronics Materials and Devices; Shuichiro Ogawa, 2015
11. Bioinformatics- Genomics and Proteomics, First Edition, Vikas Publishing House PVT LTD.

Reference Books:

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

Course Code: 19CY1004   **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL   **Credits: 5**

CO No:	COURSE OUT COME	PO	BTL
1	Demonstrate different types of semiconducting materials	1,3	1
2	Illustrate photophysical basis of light absorption and emission by materials	1,3	1
3	Sketch the underlying principles of organic light emitting diodes	5,7	1
4	Explain the concepts of solar cells modules and memory devices	1,5,6,7	1
5	An ability to apply and generate experimental skills	2,4	2

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

PROBLEM SOLVING & COMPUTER PROGRAMMING

Course code   :19SC1101   L-T-P-S : 3-0-2-0
Pre-Requisite: NIL   Credits: 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Illustrate how problems are solved using computers and programming.	PO1, PO2, PO12	2
CO2	Illustrate and use Control Flow Statements in C.	PO1, PO2, PO12	2
CO3	Interpret & Illustrate user defined C functions and different operations on list of data.	PO1, PO2	2
CO4	Implement Linear Data Structures and compare them.	PO4	2
CO5	Apply the knowledge obtained by the course to solve real world problems.	PO1, PO2, PO4	2

Syllabus:

Problem Solving Approach, **Algorithms and Algorithm Analysis**, Program Development Steps, Structure of C Program, Pre-Processor Directives, **Formatted I/O**,**C Tokens, Data Types**: Primitive, Extended and Derived Including Pointers, Operators, Precedence, Associativity , **Redirecting I/O** :Files and File Operations , **Control Flow Statements, Functions, Recursion**, Scope of Variables and Storage classes, **Arrays,** 2-Dimensional Arrays, Dynamic Memory Allocation, **Searching:** Linear Search and Binary Search, **Sorting:** Bubble Sort, **Strings**, **Structures and Unions**, Introduction to **Stacks-**Implementation using array, Introduction to Queues – Linear **Queue-**Implementation using array, Introduction to **Lists:** Single Linked List- Insertion, Deletion, Display.

Text Books:
1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:
1. Mark Allen weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education
2. E. Balagurusamy, **"**Programming in ANSI C", 4th ed., Tata McGraw-Hill Education, 2008**.**
3. Horowitz, Sahni, Anderson Freed, "Fundamentals of Data structures in C", 2nd Edition-2007.

4. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction To Data Structures with applications", 2nd Edition.

Laboratory Experiments:
1. Introduction to Basic Concepts
a) Introduction to LINUX Terminal and gcc /Turbo C compiler by writing and executing addition of two numbers c program.

b) Write an algorithm and flow chart to calculate addition of two numbers and execute this program using gcc/Turbo C.
c) Introduction to Hackerrank interface by writing a C program to print "Hello World!".
https://www.hackerrank.com/challenges/30-hello-world

2. Data types and Format Specifiers

a) Write a C program that reads a floating point number x and print the value of polynomial $3x^2+5x+9$ and store it in a variable named as y.

b) Ramshewar goes to market for buying some fruits and vegetables. He is having a currency of Rs 500 with him for marketing. From a shop he purchases 2.0 kg Apple priced Rs. 50.0 per kg, 1.5 kg Mango priced Rs.35.0 per kg, 2.5 kg Potato priced Rs.10.0 per kg, and 1.0 kg Tomato priced Rs.15 per kg. He gives the currency of Rs. 500 to the shopkeeper. Find out the amount shopkeeper will return to Ramshewar and also tell the total item purchased. Finally Print the Bill in the following format using format specifiers:

S.No.	Name Of the item	Quantity	Price per kg	Total Amount
1	Apple	2.0 kg	Rs. 50.00	Rs. 100.00

c) Write a c program to perform sum of two floating point numbers and display the sum in exponent format (Ex: 13.3478+32.1234=0.4572E02).
http://www.geeksforgeeks.org/c/FormatSpecifiers/hf7771.html

3. Operators and Predefined Functions
a) For certain electric circuit with an inductance L, resistance R and the capacitance C the damped natural frequency is given by $f=\frac{1}{LC}-\frac{R^2}{4C^2}$ compute the value of f using the Babylonian method with the highest accuracy obtainable using the data type double. Do not use any mathematical library function

The Baylonian method of finding the square-root of a number x works using the following inductive definition. Let Y_n be n^{th} approximation of $\sqrt{x}$ then

$$y_n = \begin{cases} X & \text{if } n = 0 \\ \dfrac{y_{n-1} + \dfrac{x}{y_{n-1}}}{2} & \text{if } n > 0 \end{cases}$$

b) Write a C Program by taking two sample input values 6 and 3 to perform logical operations on it and output displayed for each operation using Logical AND, OR and NOT Operators

Logical Operators		
Operator	Description	Example
&&	AND	X=6 Y=3 X<10&Y>1 Return True
11	OR	x=6 y=3 x==5 || y == 5 Return False
!	NOT	x=6 y=3 !(x==y) Return True

http://studytipsandtricks.blogspot.in/2012/06/write-c-program-by-using-logical-and.html

b) Write a c program for the following as two ships are sailing in the sea on the two sides of a lighthouse. The angle of elevation of the top of the light house is observed from the ships are 300 and 450 respectively. If the lighthouse is 100 m high, print the distance between the two ships.

Hint: Use Predefined Functions in math.h Library

www.careerbless.com/aptitude/qa/height_distance1.php

4. Conditional Statements

a) Write a C Program to input Employee Id and basic pay of an employee and then print Employee Id, HRA and Special allowance. Consider HRA is 20% of basic or Rs. 7000/52

whichever is less and Special allowance is 10% of basic pay whenever basic exceeds Rs 10000, Otherwise it is 5% of basic pay.

b) Develop a program for current billing System based on the given requirements using if else ladder

Units Consumed	Rate of Charge
0-200	Rs. 0.50 per unit
201- 400	Rs. 0.65 per unit in excess of 200 units
401- 600	Rs. 0.80 per unit in excess of 400 units
601 and above	Rs. 1.00 per unit in excess of 600 units

c) Bit-Wise-AND

5. Loops

a) Find Digits

https://www.hackerrank.com/challenges/find-digits/problem

b) Library Fine
https://www.hackerrank.com/challenges/library-fine/problem

c) Sherlock and Squares
https://www.hackerrank.com/challenges/sherlock-and-squares/problem

d) Sum of Digits of a Five Digit Number
https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem

6. Functions
a) Solve Me First
https://www.hackerrank.com/challenges/solve-me-first/problem?h_r=internal-search
b) Students Marks Sum
https://www.hackerrank.com/challenges/solve-me-first/problem?h_r=internal-search

c) Functions in C
https://www.hackerrank.com/challenges/functions-in-c/problem

7. Arrays
a) Simple Array Sum
https://www.hackerrank.com/challenges/simple-array-sum/problem?h_r=internal-search
b) Diagonal Difference
https://www.hackerrank.com/challenges/diagonal-difference/problem?h_r=internal-search

c) Grading Students
https://www.hackerrank.com/challenges/grading/problem?h_r=internal-search

8. Searching & Sorting
a) Missing Numbers
https://www.hackerrank.com/challenges/missing-numbers/problem?h_r=internal-search 53

b) Luck Balance
https:// www.hackerrank.com/challenges/ luck-balance/problem?h_r=internal-search

9. Strings
a) Super Reduced String
https://www.hackerrank.com/challenges/reduced-string/problem?h_r=internal-search

b) Two Characters
https://www.hackerrank.com/challenges/two-characters/problem?h_r=internal-search

10. Strings

a) Palindrome Index
https://www.hackerrank.com/challenges/palindrome-index/problem?h_r=internal-search

b) Anagram
https://www.hackerrank.com/challenges/anagram/problem

11. Stacks
a) Maximum Element
https://www.hackerrank.com/challenges/maximum-element/problem?h_r=internal-search
b) Balanced Brackets
https://www.hackerrank.com/challenges/balanced-brackets/problem?h_r=internal-search

12. Linked Lists
a) Insert a node at a specific position in a linked list
https://www.hackerrank.com/challenges/insert-a-node-at-a-specific-position-in-a-linked list/problem?h_r=internal-search

b) Delete a Node
https://www.hackerrank.com/challenges/delete-a-node

c) Print in Reverse

13.
a) Calculate the Nth term
https://www.hackerrank.com/challenges/recursion-in-c/problem?h_r=internal-search

b) Maximizing XOR
https://www.hackerrank.com/challenges/maximizing-xor/problem?h_r=internal-search

14.
a) Boxes through a Tunnel
https://www.hackerrank.com/challenges/too-high-boxes/problem?h_r=internal-search

b) Pointers in C
https://www.hackerrank.com/challenges/pointer-in-c/problem?h_r=internal-search

DATA STRUCTURES

Course code   :19SC1202   L-T-P-S : 3-0-2-3
Pre-Requisite: NIL   Credits: 4.5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply measures of efficiency on algorithms and Analyse different Sorting Algorithms.	PO1, PO2, PSO1, PSO2	1
CO2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	PO1, PO4, PSO1, PSO2	1
CO3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.	PO2, PO4, PSO1, PSO2	1

CO4	Analyse different representations, traversals, applications of Graphs and Heap organization.	PO2, PO1, PSO1, PSO2	1
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

| Course code | : 19ME1103 | L-T-P-S | : 0-0-4-0 |
| Pre-requisite | : NIL | Credits | : 2 |

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Practice design thinking by developing artistic skills	PO-3	2
CO2	Visualize and practice innovative design by final drafting using photogrammetric and model the design using prototyping technique	PO-4	2
CO3	Apply the concept of AI & Data analytics & finalize the requirements to design his idea	PO-5	2
CO4	Draft a report of his project from the initial stage & make a report which include scope, time and cost management of his project	PO-4	2

Gist: Introduction to Design thinking, Photogrammetry, Prototyping, Engineering Project Management, Data Analytics, Artificial Intelligence, Machine Learning

Syllabus:
Introduction to Design thinking: Design thinking, usage of visualization tool, Physics and preparation for Innovation, Idea generation and mind mapping, Strategic opportunities, Storytelling tool.**Photogrammetry:**Basic concepts of photogrammetry, types of photogrammetric techniques and measurements.**Prototyping:**Prototyping, including paper and tool-based prototyping,design principles and patterns, 3D Modeling, 360 Prototyping, 3DPrinting.**Engineering Project Management:** Scope, Time and Cost Management.**Data Analytics:** Introduction, Basics of Statistical Analysis System (SAS)**,** Logistic regression using SAS.**Artificial Intelligence:** Introduction, Turing Test, Breadth first Search techniques, Depth first Search techniques using python.**Machine Learning:** Linear regression, Naive Bayes, gradient descent algorithms using python.

Text Books:
"Complete Design Thinking Guide for Successful Professionals" by Daniel Ling
"Project Management" by K.Nagarajan, 7th Edition, New Age International Publishers.
"Augmented Reality and Virtual reality" by Timothy Jung, M.ClaudiaTomDieck, Springer.
"Rapid Prototyping: Principles and Applications"by Chua C.K., Leong and Lim. C.S, 2nd Edition, World Scientific.
"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/introduction-virtual-reality?specialization=virtual-reality
3. https://www.coursera.org/learn/scope-time-management-cost

DESIGN TOOLS WORKSHOP –II

Course code   : 19SC1209   L-T-P-S   : 0-0-4-0
Pre-requisite   : NIL   Credits   : 2

Mapping of Course Outcomes with PO/PSO:

CO No.	Course Outcome	PO/PSO	BTL
CO1	Practice the design ideology by artistic skill	PO-3	2
CO2	Visualize the design ideology by using VR technology	PO-4	2
CO3	Visualize the design ideology by incorporating VR technique	PO-5	2
CO4	Visualize and present his design idea by applying AR technique	PO-4	2

Gist: Design Thinking in Modern Art & Ideas, Virtual Reality, Room Scale VR, Holography, Mirror Reality, Augmented Reality. *Electronics components, Soldering, Wiring, Circuit Simulation, Bread-boarding, Prototyping on GP PCBs, Introduction and Applications of Arduino Micro-Controller Boards [DEPT.SPECIFIC].*

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

Web References:
https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
https://www.coursera.org/learn/uva-darden-design-thinking-innovation?
https://www.coursera.org/learn/modern-art-ideas?

TECHNICAL SKILLS – 1 (CODING)

Course code   : 19SC1106   L-T-P-S   : 0-0-0-6
Pre-requisite : NIL   Credits   : 1.5

Mapping of Course Outcomes (CO) to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	PO1,PO2,PSO1	2
CO2	Build solutions for problems on Numbers and array based problems , functions, recursion	PO1,PO2,PSO1	2
CO3	Solve problems solutions for character/string based problems and pointers	PO1,PO2,PSO1	2
CO4	Build solutions to programs on Data structures concepts.	PO1,PO2,PSO1	2

Syllabus:

Basic problems, Pattern based problems, Number based problems, Array based problems (one dimensional and two dimensional), character and string based problems, functions and recursion (class and objects for java), pointer based problems, function pointers and array pointers (For C Users), linked lists, queues, stack problems.

Tools for References: http://hackerrank.com

Session No.	Problem	Level	Reference
1	Design an algorithm and draw flowchart to print Student ID and Name Design an algorithm and draw flowchart to compute area of circle considering radius as input. Design an algorithm and draw flowchart to convert given Celsius temperature to Fahrenheit.	Easy EasyEasy	
2	Design an algorithm and draw flowchart to check if a given number is even or odd.	Easy	

	Design an algorithm and draw flowchart to find the smallest among 3 given numbers. Given the marks obtained by the students, maximum marks and pass marks in three subject's, design an algorithm and draw flowchart to find whether the student passed or not, if the student passes determine the percentage marks and grade. The grade is determined as follows: percentage marks >=80 grade is A percentage marks >=70 and <80 grade is B percentage marks >=60 and <70 grade is C percentage marks >=50 and <60 grade is D percentage marks <50 grade is F Design and algorithm to calculate grade of the student by reading three subject marks.	Easy Easy	
3	Design algorithm and flowchart to pint first n natural numbers. Design algorithm and flowchart to print multiplication table for a given number. Design algorithm and draw flowchart to check whether a given number is a Perfect Number or not.	Easy Easy Easy	
4	Day 0: Hello World	Easy	https://www.hackerrank.com/challenges/30-hello-world/problem
	"Hello World!" in C Day 1: Data Types	Easy Medium	https://www.hackerrank.com/challenges/hello-world-c/problem?h_r=internal-search https://www.hackerrank.com/challenges/30-data-types/problem?h_r=internal-search

5	Playing with Characters	Easy	https://www.hackerrank.com/challenges/playing-with-characters/problem
	Day 2: Operators	Easy	https://www.hackerrank.com/challenges/30-operators/problem
	Sum and Difference of 2 numbers	Easy	https://www.hackerrank.com/challenges/sum-numbers-c/problem
6	Cutting paper squares	Easy	https://www.hackerrank.com/challenges/p1-paper-cutting/problem
	Maximum height Triangle	Medium	https://www.hackerrank.com/challenges/lowest-triangle/problem
7	Day 3: Introduction to Conditional Statements	Easy	https://www.hackerrank.com/challenges/30-conditional-statements/problem
	Conditional Statements in C	Easy	https://www.hackerrank.com/challenges/conditional-statements-in-c/problem
8	Library Fine	Medium	https://www.hackerrank.com/challenges/library-fine/problem?h_r=internal-search
	Day 26: Nested Logic	Medium	https://www.hackerrank.com/challenges/30-nested-logic/problem
9	Conditional Statements	Easy	https://www.hackerrank.com/challenges/30-nested-logic/problem
	Conditional Statements-2	Medium	https://www.hackerrank.com/challenges/library-fine/problem?h_r=internal-search
10	Day 5: Loops	Easy	https://www.hackerrank.com/challenges/30-loops/problemhttps://www.hackerrank.com/challenges/30-binary-numbers/problem https://www.hackerrank.com/challenges/maximum-draws/problem
	Day 10: Binary Numbers	Medium	
	Maximum Draws	Easy	
	For loop in C	Easy	https://www.hackerrank.com/challenges/for-loop-in-c/problem

11	Handshake	Easy	https://www.hackerrank.com/challenges/handshake/problem
	Utopian Tree	Medium	https://www.hackerrank.com/challenges/utopian-tree/problem?h_r=internal-search
12	Sum of Digits of a Five Digit Number	Easy	https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem
	Angry Professor	Medium	https://www.hackerrank.com/challenges/angry-professor/problem?h_r=internal-search
	Day 29: Bitwise AND	Medium	https://www.hackerrank.com/challenges/30-bitwise-and/problem
13	Bitwise Operators	Hard	https://www.hackerrank.com/challenges/bitwise-operators-in-c/problem
			https://www.hackerrank.com/challenges/flipping-bits/problem
	Flipping Bits	Easy	
14	Find Digits	Medium	https://www.hackerrank.com/challenges/find-digits/problem
	Day 25: Running time & Complexity	Medium	https://www.hackerrank.com/challenges/30-running-time-and-complexity/problem
15	Staircase	Medium	https://www.hackerrank.com/challenges/staircase/problem?h_r=internal-search
	Printing Pattern using Loops	Hard	https://www.hackerrank.com/challenges/printing-pattern-2/problem
16	Day 7: Arrays	Easy	https://www.hackerrank.com/challenges/30-arrays/problem
	Simple Array Sum	Easy	https://www.hackerrank.com/challenges/simple-array-sum/problem
			https://www.hackerrank.com/challenges/a-very-big-sum/problem

	Very Big Sum	Easy	
17	Grading Students	Easy	https://www.hackerrank.com/challenges/grading/problem
	Birthday Cake Candles	Medium	https://www.hackerrank.com/challenges/birthday-cake-candles/problem
			https://www.hackerrank.com/challenges/plus-minus/problem
	Plus Minus	Easy	
18	1D Arrays in C	Easy	https://www.hackerrank.com/challenges/1d-arrays-in-c/problem
	Mini-Max Sum	Easy	https://www.hackerrank.com/challenges/mini-max-sum/problem?h_r=internal-search
			https://www.hackerrank.com/challenges/30-sorting/problem
	Day 20: Sorting	Medium	
19	Day 6: Let's Review	Easy	https://www.hackerrank.com/challenges/30-review-loop/problem
			https://www.hackerrank.com/challenges
	Time Conversion	Medium	/time-conversion/problem?h_r=internal-search
20	Strong Password	Easy	https://www.hackerrank.com/challenges/strong-password/problemhttps://www.hackerrank.com/challenges
	Caesar Cipher	Medium	/caesar-cipher-1/problem
21	Printing Tokens	Easy	https://www.hackerrank.com/challenges/printing-tokens-/problem
	Digit Frequency	Medium	https://www.hackerrank.com/challenges/frequency-of-digits-1/problem
22	Diagonal Difference	Easy	https://www.hackerrank.com/challenges/diagonal-difference/problem
	Day 11: 2D Arrays	Medium	https://www.hackerrank.com/challenges/30-2d-arrays/problem
23	Lonely Integer	Easy	https://www.hackerrank.com/challenges/lonely-integer/problem
	Maximizing XOR	Medium	https://www.hackerrank.com/challenges/maximizing-xor/problem

	Array Reversal	Easy	https://www.hackerrank.com/challenges/reverse-array-c/problem
24	Arrays-2	Easy	https://www.hackerrank.com/challenges/reverse-array-c/problem
	Arrays-3	Medium	https://www.hackerrank.com/challenges/arrays-3
25	Compare the Triplets	Easy	https://www.hackerrank.com/challenges/compare-the-triplets/problem
	Constructing a number	Medium	https://www.hackerrank.com/challenges/constructing-a-number/problem
26	Find the point	Easy	https://www.hackerrank.com/challenges/find-point/problem
	Calculate the Nth Term	Medium	https://www.hackerrank.com/challenges/recursion-in-c/problem
27	Recursion	Hard	https://www.hackerrank.com/challenges/recursion-in-c/problem
28	Small Triangles, Large Triangles	Medium	https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem
29	Post Transition	Hard	https://www.hackerrank.com/challenges/post-transition/problem
30	Structuring the document	Hard	https://www.hackerrank.com/challenges/structuring-the-document/problem
31	Maximum Element	Hard	https://www.hackerrank.com/challenges/maximum-element/problem?h_r=internal-search
32	Queue using two stacks	Hard	https://www.hackerrank.com/challenges/queue-using-two-stacks/problem?h_r=internal-search
33	Insert a node at a specific position in linked list	Hard	https://www.hackerrank.com/challenges/insert-a-node-at-a-specific-position-in-a-linked-list/problem?h_r=internal-search
34	Print in reverse	Hard	https://www.hackerrank.com/challenges/print-the-elements-of-a-linked-list-in-reverse/problem?h_r=internal-search
35	Get node value	Hard	https://www.hackerrank.com/challenges/get-the-value-of-the-node-at-a-specific-position-from-the-tail/problem?h_r=internal-search

36	Compare two linked lists	Hard	https://www.hackerrank.com/challenges/compare-two-linked-lists/problem?h_r=internal-search

OBJECT ORIENTED PROGRAMMING

| Course code | : 19SC1203 | L-T-P-S | : 3-0-2-0 |
| Pre-requisite | : NIL | Credits | : 4 |

Mapping of Course Outcomes to Program outcomes:

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	2
CO2	Apply access control, Inheritance, Packages.	PO3, PO5, PSO2	2
CO3	Apply Interfaces, Exception Handling, multi- threading, I/o.	PO3, PO5, PSO2	2
CO4	Apply collection framework and event driven programming.	PO3, PO5, PSO2	2
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	1

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

Digital Logic & Processors

Course code: **19EC1101**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 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	2
CO2	Combinational systems design using standard gates and minimization methods	1,2	2
CO3	Sequential systems: Design of counters using flip flops.	1,2	2
CO4	Understanding PLA's, PAL's, FPGA's and processors	2	2
CO5	Analyzing and realization of Boolean functions, half adder, encoders, decoders, flip flops and counters.	5	2

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

Basic Electronic Circuits

Course code: **19EC1213**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic electronic components.	1	2
CO2	Understanding of junction diode, I-V characteristics and applications of diodes.	1	2
CO3	Understanding the design and working of power supply and regulators using zener diodes.	1	2
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

Electronic Workshop-II (Electronic System Design Workshop)

Course code: **19EC2111**   L-T-P-S: 1-0-2-2

Pre-requisites   : NIL   Credits : 2.5

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**	**2**
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)

Electronic Workshop-III (IOT Applications)

Course code: **19EC2214**   L-T-P-S: 1-0-2-4

Pre-requisites   : 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.	**1,3**	**2**
CO2	Study of Raspberry Pi with different communication module to design IOT applications	**1,3**	**2**
CO3	Designing of Web Page, control and analyze sensor data through it	**1,3**	**2**
CO4	Understanding the inbuilt protocols and IOT management with STM 32.	**3**	**2**

Gist: IoT nodes, various Sensors, IoT Applications Design hands-on

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

IT Workshop (HTML, XML, Web design)

Course code: **19EC2112**   L-T-P-S: 1-0-2-0

Pre-requisites   : NIL   Credits : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the HTML coding	4	2
CO2	Understand the XML	4	2
CO3	Learning of web designing and hosting	5	2
CO4	Hands on app development using Android studio for mobile applications.	5	2

Gist: HTML, XML, Web Design and App development

Syllabus:

Develop Home Page – HTML/ XML – Word Press – Arduino Interfacing – Mobile Interfacing– Native Apps for Android Phone – Raspberry Pi API basics – Raspberry pi Interfacing – Mobile AppsDevelopment using Raspberry pi – Project Development.

Text Books :
1. "HTML & CSS Design and Build Websites" by Jon Duckett - John Wiley & Sons, Inc
2."Beginning Arduino Programming Writing Code for the Most Popular Microcontroller Board in theWorld" by Brian Evans - Technology in Action
3. "Getting Started with Raspberry pi" by MattRichardson and Shawn Wallace – O'Reilly
4. "THE ARDUINO PROJECTS BOOK" by Scot Fitzgeraldand Michael Shiloh.

MOOCS :https://www.youtube.com/watch?v=v4oN4DuR7YU

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	3
CO3	Plan the necessary activities towards solving the problem through ideation and prototyping	PO4, PO5, PO11	3
CO4	evaluate the solution and refine them based on the customer feedback	PO3, PO9	3

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	3
CO3	Plan the necessary activities towards solving the problem through ideation and prototyping	PO4, PO5, PO11	3
CO4	evaluate the solution and refine them based on the customer feedback	PO3, PO9	3

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

PROFESSIONAL CORE COURSES

Computer Organization and Architecture

Course code: **19EC1202**   L-T-P-S: 2-0-0-0

Pre-requisites   : NIL   Credits : 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

19EC2103 – Analog Electronic Circuit Design

Course code: **19EC2103**   L-T-P-S: 3-0-2-2

Pre-requisites   : NIL   Credits : 4.5

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**	**3**
CO2	Understand various types of FET's, IC Types and analyze FET as an Amplifier	**1,3**	**3**
CO3	Understand the Linear & Non-linear application of Op-AMP and analyze active filters	**1,3**	**3**
CO4	Analysis of different types of oscillators, filter and regulators.	**1,3**	**3**
CO5	Design and Testing of Analog circuits for realistic applications	**5**	**2**

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

Communication Signals & System Design

Course code: **19EC2104**   L-T-P-S: 3-1-0-0

Pre-requisites   : NIL   Credits : 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.	**1,6/1,2**	**3**
CO2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	**1,3/1,2**	**3**
CO3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	**1,2,8/1,2**	**3**
CO4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain	**12/1,2**	**2**

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.

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	1
CO2	Explore the basic digital communication systems and principles	1, 3	3
CO3	Learning various line coding procedures and signalling schemes to facilitate data communications.	1, 3	3
CO4	Understand the concepts of multiple access and various types of networks.	1, 3	3
CO5	Analysis and design of Modulation and Demodulation features of various Analog & Digital Communication Systems.	5	2

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.

Embedded Controllers

Course code: **19EC2106**   L-T-P-S: 2-0-3-2

Pre-requisites   : NIL   Credits : 2

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**	**1**
CO3	Analyse the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers	**3**	**3**
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**	**1**

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.

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**	**3**
CO2	Study of wave propagation in wave guides, coaxial cables and other materials.	**1,2**	**1**
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**	**1**

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

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	2
CO3	Analysis and Design the Digital filters: Digital IIR	2	2
CO4	Understand and apply multi-rate signal processing, interpolation and decimation concepts	3	3
CO5	Design and Analysis of LTI Systems and Filters	3	3

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

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	2
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	3

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/

19EC2209-Introduction to 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**	**2**
CO2	To understand the applications and tools of AI	**1,2**	**2**
CO3	To understand the concepts of AI searching techniques and ANN models	**1,2**	**2**
CO4	To Implement AI and ANN Models for real time problems	**1,2**	**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	1
CO2	Understand the networking technologies	1	1
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	1

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

Course code: **19EC3015**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the MOS device fabrication process	**1,2**	**2**
CO2	Analysis of MOS operation principles, characteristics and scaling process	**1,2**	**3**
CO3	Constructing the Transistor Level Logic circuits and understand the MOS layout design rules	**1,2**	**1**
CO4	Study of MOS circuit performance and testing principles	**1,2**	**1**
CO5	Create the MOS circuit modules through project-oriented approach using e-CAD tools	**1,2**	**1**

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

Course code: **19EC3016**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits :4

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**	**3**
CO2	Understand the basic concepts of mobile radio propagation	**3,4,5**	**2**
CO3	Understand the basic concepts of equalization and diversity techniques	**3,4,5**	**2**
CO4	Understand and applications of concepts of multiple access techniques	**1,2**	**2**
CO5	Analysis and design of electronic circuits for modern communication standards	**1,2,3,4,5**	**1**

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.

RF System Design

Course code: **19EC3017**   L-T-P-S: 3-0-2-0
Pre-requisites   : NIL   Credits : 4

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	1
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	3
CO3	Analyze Stability Considerations and stabilization methods to design RF Amplifiers Using Small Signal Analysis	2,3	2
CO4	Analyze high frequency oscillator configuration and mixer designs.	3,4	2
CO5	Analysis and design of RF electronic circuits	3,4	3

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

Course code: **19EC3018**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 4

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	1,2	2
CO3	Understand and analysis of various modern bio-medical instruments	1,2	1
CO4	Study of modern IoT application for health care	2,4	2
CO5	Design and development of IoT applications for health care	3,4	2

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

Electronics Instruments & Automation

Course code: **19EC3019**   L-T-P-S: 3-0-2-0
Pre-requisites   : NIL   Credits : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of measurement and calibration	**1,2**	**3**
CO2	Understand and study of various electronic instruments	**1,2**	**1**
CO3	Understand the basics of control systems and automation	**1,2**	**1**
CO4	Study and analysis of industrial automation	**2,4**	**1**
CO5	Design and development electronic measurement circuits suitable of automation	**3**	**2**

Syllabus

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

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

Course code: **19EC3020**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 4

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	**1,2**	**2**
CO3	Understand and application of design objectives, industry & market forces and product design strategies	**1,2**	**2**
CO4	Understand and analyze the product design goals, methodologies.	**1,2**	**2**

 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: 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: 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: 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) 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: 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): 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

Course code: **19EC3021**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 4

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	3
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.	2,4	2

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)

Course code: **19EC3022**   L-T-P-S: 3-0-2-0

Pre-requisites   : NIL   Credits : 4

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	**1,2**	**3**
CO3	Application of various ML techniques of kMeans, kNN, SVM and GMM	**1,2**	**2**
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**	**3**

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

IoT

Wireless sensor Networks & IOT Applications

Course code: **19EC3051**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of wireless sensor network technologies.	1,2	3
CO2	Study of BLE protocols in WSN security and power applications.	1,2	1
CO3	Study and application of IOT and WSN for smart cities/ villages.	1,2	1
CO4	Study of various IoT application in various domains	2,4	1

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

Solar Photo-Voltaic cells & Solar Power Arrays

Course code: **19EC3052**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of solar photo-voltaic cell structure	1,2	3
CO2	Study of basic physics and components of solar photo voltaic cells	1,2	1
CO3	Study and design of solar PV systems and testing	1,2	1
CO4	Analysis and design of SPV arrays	2,4	1

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/

Electronic Systems for Renewable Energy & Smart Grid

Course code: **19EC3053**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of renewable energy electronics	1,2	3
CO2	Study and analysis of electronics systems for renewable energy sources	1,2	1
CO3	Analysis and study of smart grid sub-systems and circuits	1,2	1
CO4	Analysis of electrical smart grids	2,4	1

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

IOT Applications for Smart Cities

Course code: **19EC3054**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

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

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

Systems for Smart Cities & Smart Villages
Course code: **19EC3055**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

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

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

Low Power VLSI

Course code: **19EC3061**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the power dissipation in MOS structure	**1,2**	**3**
CO2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits	**1,2,3**	**1**
CO3	Apply low power techniques for various combinational circuits.	**1,2,3**	**1**
CO4	Design and analysis of low power techniques for memories.	**1,2**	**1**

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.

Algorithms for VLSI Design Automation

Course code: **19EC3062**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of computational and automation tools	1	1
CO2	Understanding of VLSI layout modeling	2	1
CO3	Understand and analysis of hardware models	1,3	1
CO4	Analysis and understanding the FPGA technologies	1,3	1

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.

ASIC and FPGA Chip Design

Course code: **19EC3063**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 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**	**3**
CO2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	**3**	**1**
CO3	To study PLD structures and design process. Study of different CPLD and FPGA architectures	**1,3**	**1**
CO4	To understand different physical process.	**3**	**1**

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.

Field Programmable Gate Arrays (FPGAs): Introduction; Xilinx – XC3000, XC4000, Altera – FLEX 8000/10000, Actel – ACT – 1, 2, 3 architectures. Physical Design: Introduction, Partitioning, Floor planning, Placement, Routing.

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

VLSI Sub-system Design and Design for Testability

Course code: **19EC3064**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the design flow and methodologies of VLSI sub-system	**1,3**	**3**
CO2	Study of memory and array sub systems	**1,3**	1
CO3	Analysis of fault tolerant designs	**1,3**	1
CO4	Design of testing of VLSI systems	**1,3,5**	1

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.

Semiconductor Memories & MEMS

Course code: **19EC3065**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Pre-requisites : NIL   Credits : 2

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of non-volatile memories	1,2	3
CO2	Understanding of random access memories	1,3	1
CO3	Analysis and understanding memory fault modeling and testing	1,3	1
CO4	Understand the basics of MEMS and applications	1,3	1

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.

Analog IC Design & Applications

Course code: **19EC3063**   L-T-P-S: 3-0-0-0
Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of programmable IC design process and Verilog HDL	1,3	3
CO2	Understand and analysis of ASIC design and PLD's	1,3	1
CO3	Analysis and design of CPLD's and FPGA's	1,2,3	1
CO4	Analysis of modern IC's and chips	1,2,3	1

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).

Control Systems & Introduction to Robotics

Course code: **19EC3071**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of control systems	**1,2**	**3**
CO2	Analysis of control systems in time and frequency domains	**1,2**	**1**
CO3	Understanding the basics of robotics	**1,2**	**1**
CO4	Analysis and understanding of kinetics, dynamics and control of robots.	**1,2**	**1**

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 o r d e r 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.

Autonomous Vehicles & Automotive Electronics

Course code: **19EC3072**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basics of autonomous vehicles	1,2	3
CO2	Understand the principles of sensors and actuators	1,2	1
CO3	Analysis and understanding of automotive electronic systems	1,2	1
CO4	Study of various miscellaneous topics	1,2	1

Syllabus:

(i)Introduction to Autonomous Vehicles

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:

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) : 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 : 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)

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: 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:

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: 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/

Course code: **19EC3073**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the fundamentals of robotics	**1,2**	**3**
CO2	Analysis and understanding the various parameters of robots	**1,2**	**1**
CO3	Analysis and understanding the mechanisms involved in various robots.	**1,2**	**1**
CO4	Analysis of various case studies and humanoid applications of robots	**1,2**	**1**

Syllabus:

Introduction to Robotics (ITR):
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:
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) :
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)]: 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 :

[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

Computer Vision & Applications

Course code: **19EC3074**   L-T-P-S: 3-0-0-0
Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of the fundamental concepts related to multi-dimensional signal processing.	1,2	3
CO2	Understanding of the feature extraction, pattern analysis visual geometric modelling, stochastic optimization.	1,2	1
CO3	Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision.	1,2	1
CO4	Applications range from Biometrics, Medical diagnosis,	1,2	1

document processing, mining of visual content, to surveillance, advanced rendering.		

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)

(b) HMI Tech.: GMOS Models, CMN-GOMS, Fitts Laws, Hick-Hyman Laws, Norman's 7 Principles

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

Human Machine Interface & Brain Machine Interface

Course code: **19EC3075**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Basic Idea of Human Machine Interactions, and its Goals	**1,2**	**3**
CO2	Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms	**1,2**	**1**
CO3	Understand the Basic Idea of Brain Machine Interactions, and brain waves	**1,2**	**1**
CO4	Apply an interactive design process and universal design principles to designing HCI/BMI systems	**1,2**	**1**

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.

(b) HMI Tech: GMOS Models, CMN-GOMS, Fitts laws, Hick-Hyman laws, Norman's 7 principles:

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

Designing Automation Systems & Assistive Robotic Systems

Course code: **19EC3076**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the block diagrams and design considerations of automation systems.	1	3
CO2	Study of home automation, industrial robots and robotic arms	1	1
CO3	Applications of robots for human safety.	1,2	1
CO4	Study and understanding the assistive robotic systems.	1,2	1

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 & Image Processing

Speech Signal Processing

Course code: **19EC3081**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

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

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

Digital Image Processing

Course code: **19EC3082**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 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.	3	3
CO2	Selected, to simulate algorithms for Systems using 2D methods	3,5	1
CO3	Selected, to create a problem identifier and learner, to find solutions in complex search space.	3,5	1
CO4	Selected, with simulations that can apply 2D models to solve Image processing problems.	3,5	1

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/

19EC3083 – 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	**1,2**	**1**
CO2	Image Enhancement in Spatial and Frequency domain	**1,2**	**1**
CO3	Image Segmentation and Compression	**1,2**	**1**
CO4	Morphological Image Processing and Advanced Topics	**2,4**	**1**

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

Statistical Signal Processing

Course code: **19EC3084**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Random variables and random processes	1,2	1
CO2	Explain the estimation theory and methods of estimation criteria.	1,2	1
CO3	Explain and analyze the estimation of signal and spectral analysis	1,2	1
CO4	Explain the Kalman filters and Apply and evaluate Statistical signal processing concepts to various applications under transform domain.	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

Adaptive Signal Processing

Course code: **19EC3085**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Basic concepts related to adaptive systems	1,2	1
CO2	Understand the Searching performance surface-stability and rate of convergence	1,2	1
CO3	Understand the concepts of Least mean square and its algorithms	1,2	1
CO4	To know the applications and know the adaptive modeling and system identification	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

Detection and Estimation of Signals

Course code: **19EC3086**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of detection theory and binary decisions.	**1,2**	**1**
CO2	Understand the theory and properties of estimation theory.	**1,2**	**1**
CO3	Understand the state estimation using various techniques.	**1,2**	**1**
CO4	Understand and application of statistical estimation of parameters.	**2,4**	**1**

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.

19EC3087 – 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**
CO2	Modalities, Signal Processing Methods	**1,2**	**1**
CO3	Modern Biomedical Technologies & Instruments	**1,2**	**1**
CO4	Advanced Applications	**2,3**	**1**

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

Wireless Communications

19EC3091 – Information Theory & Coding

Course code: **19EC3091**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts of coding methodology	**1,2,3,4,5**	**1**
CO2	Understand and evaluate different communication channels.	**1,2,3,4,5**	**1**
CO3	Analysis of various coding techniques	**1,2,3,4,5**	**1**
CO4	Analysis of various Error detection and correcting methods	**1,2,3,4,5**	**1**

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

4G Wireless Technologies & Cellular Communications

Course code: **19EC3092**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the concepts of multiple carrier systems	**1,2,3,4,5**	**1**
CO2	Understanding Spatial Multiplexing and its applications	**1,2,3,4,5**	**1**
CO3	Evaluate the performance of multicarrier systems	**1,2,3,4,5**	**1**
CO4	Understanding the basics of cellular communication	**1,2,3,4,5**	**1**

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,

Satellite Communications

Course code: **19EC3093**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the basic concepts of satellite communication	1,2,3,4,5	1
CO2	Design general satellite orbital terms and elements	1,2,3,4,5	1
CO3	Understand satellite subsystems which compromise space, earth segments and design uplink and downlink budgets in satellite communication	1,2,3,4,5	1
CO4	Understand the basic concepts of multiple access techniques, satellite navigation and GPS.	1,2,3,4,5	1

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.

Optical Communication & Network

Course code: **19EC3094**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts of optical communication	1,2,3,4,5	1
CO2	Analyze different optical sources, materials and structures	1,2,3,4,5	1
CO3	Evaluate different optical network protocols	1,2,3,4,5	1
CO4	Understand different optical networks	1,2,3,4,5	1

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,

Next Generation Wireless Technologies (WCDMA, GPRS, GSM, UMTS)

Course code: **19EC3095**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding different mobile techniques	**1,2,3,4,5**	**1**
CO2	Understand vehicular communication systems	**1,2,3,4,5**	**1**
CO3	Evaluate millimetric wave systems	**1,2,3,4,5**	**1**
CO4	Understanding the Misc in mobile communications.	**1,2,3,4,5**	**1**

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

Data Communication & Networks

TCP/IP other Protocol Suite

Course code: **19EC4051**   L-T-P-S: 3-0-0-0

Pre-requisites   : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts Internet Architecture	**1,2**	**1**
CO2	Able to Identify different configuration setups	**3,4,5**	**1**
CO3	Understand the concept of TCP and its design issues	**3,4,5**	**1**
CO4	Analysis of various protocols at each layer	**1,2**	**1**

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)

VoIP Systems & Broad Band Networks

Course code: **19EC4052**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts Internet Telephony	**1,2**	**1**
CO2	Able to Identify different VoIP Architecture and protocols	**3,4,5**	**1**
CO3	Understand the concept of Broadband Services	**3,4,5**	**1**
CO4	Analysis of Optical Network and Multimedia concepts	**1,2**	**1**

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

5G Mobile, Wireless Technologies & IEEE 802 Standards

Course code: **19EC4053**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL

CO1	Understand the basic concepts 4G & 5G Technologies	**1,2**	**1**
CO2	Able to Identify different 5G Channels and Networking concepts	**3,4,5**	**1**
CO3	Understand the concept of 5G Evaluation and its Applications	**3,4,5**	**1**
CO4	Analysis of various IEEE standards	**1,2**	**1**

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, 1[st]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

Cloud-Computing & Network Security

Course code: **19EC4054**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of Cloud Networking	**1,2**	**1**
CO2	Able to Identify different Topologies and Architecture standards	**3,4,5**	**1**
CO3	Understand the concept of Cloud-Computing and Security	**3,4,5**	**1**
CO4	Analysis of various Network Security issues	**1,2**	**1**

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

IP Multimedia Sub-System & Emerging Technologies (Cloud, IOT, NFV, SDN)

Course code: **19EC4055**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concepts IMS and its Architecture	**1,2**	**1**
CO2	Able to Identify different IMS Protocol Stacks and its Operation	**3,4,5**	**1**
CO3	Able to Identify different various IMS services	**3,4,5**	**1**
CO4	Analysis of various Emerging Tech. of IMS	**1,2**	**1**

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**

RF, Microwave & Radars

19EC3111 – Microwave Engineering

Course code: **19EC4061**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Able to Differentiate different Microwave components	**1,2**	**3**
CO2	Able to Identify transformers and microwave resonators	**1,2**	**2**
CO3	Understand the concept of design of different microwave filters	**1,2**	**2**
CO4	Analyse the applications of microwave and millimetric wave circuits	**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

Antenna Design & Wave Propagation

Course code: **19EC4062**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :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**	**3**
CO2	Able to Identify different types of antennas and arrays	**1,2**	**2**
CO3	Understand the concept of antenna measurements, design and testing.	**1,2**	**2**
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

Course code: **19EC4063**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 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 Transmitters , Receivers and design of simple Radar Receiver	1	1
CO2	Understand various types of Radars	1,2	3
CO3	Understand the principles of various Radars systems used in different applications	3	1
CO4	Understand the basic concepts related to different systems and sensors for navigation.	3	1

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.

Modern Antennas, Millimeter Waves & Applications

Course code: **19EC4064**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand and analysis of modern antenna design	1	1
CO2	Understand the concepts of mm waves and meteorological applications.	1,2	3
CO3	Understand and analysis of mm wave circuits.	3	1
CO4	Study of applications of modern antennas and mm wave radar.	3	1

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.

Electronic Warfare, EMI & EMC

Course code: **19EC4065**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic concept of Electronic Warfare	1	1
CO2	Able to identify the different Jamming techniques and its methodologies	2,3	3
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.

Data Computing

Machine Learning

Course code: **19EC4071**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding learning systems	1,2	3
CO2	Analyze unsupervised learning techniques	1,2	2
CO3	Analyze supervised learning techniques	1,2	2
CO4	Apply deep learning for real world problems	2,4	2

Syllabus:

Introduction to Machine Learning: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation, Learning from data, Overfitting, regularization, cross-validation.

Unsupervised & Semi-Supervised Learning: Clustering (K-means, GMMS), Factor Analysis (PCA, LDA), Learning Theory: Bias and Variance, Probably Approximately Correct (PAC) Learning.

Supervised Learning: Nearest Neighbour, Naive Bayes, Support Vector Machines, Neural Networks, Decision Trees, Logistic Regression.

Structured Models & Applications: Bayesian Network, Hidden Markov Models, Reinforcement Learning, Applications of ML to Perception: Computer Vision, Natural Language Processing, Design and implementation Machine Learning Algorithms, Feedforward Networks for Classification, Convolutional Neural Network based Recognition using Keras, Tensorflow and OpenCV, Speaker recognition, Biometrics.

Text Books

1   Mitchell, Tom. *Machine Learning*. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.

2   MacKay, David. *Information Theory, Inference, and Learning Algorithms*. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989.

Reference Books

1   E. Alpaydin, "Machine Learning", MIT Press, 2010.

2   K. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Web References

1   https://www.innoarchitech.com/blog/machine-learning-an-in-depth-non-technical-guide

2	https://machinelearningmastery.com/supervised-and-unsupervised-machine-learning-algorithms/
3	https://towardsdatascience.com/introduction-to-hidden-markov-models-cd2c93e6b781
4	https://www.codementor.io/james_aka_yale/a-gentle-introduction-to-neural-networks-for-machine-learning-hkijvz7lp

Data Sciences & Big-Data

Course code: **19EC4072**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analysis of statistical methods for Big data	1,2	3
CO2	Understanding big data flat forms for large seal data storage	1,2	2
CO3	Analyze big data streaming flatforms for past data	1,2	2
CO4	Applying big data for real world flatforms	2,4	2

Syllabus:

Basics of Data Science & Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions, Test of Hypothesis- Testing for Attributes-Mean of Normal Population, Analysis of variance ANOVA, Tabular data- Power and the computation of sample size- Advanced data handling-Multiple regression- Linear models- Logistic regression- Rates and Poisson regression-Nonlinear curve fitting.

Inferential Big Data: Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream-Filtering Streams-Counting Distinct Elements in a Stream- Flat Forms-Big Data Storage-Large Scale Data Storage- Analysis.

Big Data Streaming & Analysis: Estimating Moments-Decaying Window – Hadoop Distributed File System – Components of Hadoop Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming-Developing a Map Reduce Application- Anatomy of a Map Reduce Job Run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features - Hadoop environment, R, Flat Form for Past Data, Analysis.

Applications & Case Studies: Real time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions - Applications on Big Data Using Pig and Hive - Visual data analysis applications- Other applications to real world, smart cities.

Text Books

1	Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
2	Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012.

Reference Books

1   Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2   Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
3   Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007.

Web References

1   https://medium.com/ml-research-lab/how-to-self-learn-statistics-of-data-science-c05db1f7cfc3
2   https://nptel.ac.in/courses/110106064/
3   https://www.techopedia.com/definition/31752/big-data-streaming
4   https://onlinecourses-archive.nptel.ac.in/noc19_cs33/preview

Pattern Recognition

Course code: **19EC4073**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand basic concepts in pattern recognition	1,2	3
CO2	Understanding Generative Learning Models	1,2	2
CO3	Analyze the structured pattern recognition	1,2	2
CO4	Apply pattern recognition techniques in practical problems.	2,4	2

Syllabus:

Introduction and general pattern recognition: Pattern Recognition (PR), Pattern Recognition Approaches, Examples of PR Applications, Pattern Recognition Extensions.

Statistical pattern recognition: Introduction, Supervised, Parametric Approaches, Unsupervised Approaches. Bayes Classifier: Bayes Theorem, Minimum Error Rate Classifier, Estimation of Probabilities Comparison with the NNC, Naive Bayes Classifier. Hidden Markov Models: Markov Models for Classification, Hidden Markov Models, HMM Parameters, Learning HMMs, Classification Using HMMs, Classification of Test Patterns.

Syntactic (structural) pattern recognition & NN Classifiers: Introduction, Structural Analysis Using Constraint Satisfaction and Structural Matching, The Formal Language-based Approach, Learning/Training in the Language-based Approach. Nearest Neighbour Based Classifiers: Nearest Neighbour Algorithm, Variants of the NN Algorithm, Use of the Nearest Neighbour Algorithm for Transaction Databases, Minimal Distance Classifier (MDC).

Applications of Pattern Recognition: Finger printing, cursive characteristic recognition, Biometrics, Rice inspection, Food quality analysis, etc.

Text Books

1   R. O. Duda, P. E. Hart, and D. G. Stork, *Pattern Classification*, 2nd edition, Wiley-Inter science. ISBN 0-471-05669-3 .

2   Pattern Recognition, An Algorithmic Approach, M. Narasimha Murty · V. Susheela Devi, 2011, Universities Press (India) Pvt. Ltd, Co-Published by Springer.

Reference Books

1   Hastie, Tibshirani, Friedman," The Elements of Statistical Learning," Springer.

Web References

1   https://nptel.ac.in/courses/117108048/
2   https://www.minigranth.com/pattern-recognition/pattern-recognition-approaches/
3   http://37steps.com/189/statisticalpr/
4   https://www.youtube.com/watch?v=mfePdDh9t6Q&list=PLbMVogVj5nJQJMLb2CYw9rry0d5s0TQRp

Block-Chain & Cyber Security

Course code: **19EC4074**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits : 3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding the major components of block chain	**1,2**	**3**
CO2	Understanding bit coin and cryptocurrency	**1,2**	**2**
CO3	Analyze the cyber security issues	**1,2**	**2**
CO4	Apply block chain technique for various domains	**2,4**	**2**

Syllabus:

Introduction to Block Chain: Introduction- Need of Black-chain security-Characteristics of Blockchain Technology-Types of Blockchains-The Architecture of Blockchain Technology-How Blockchain Technology Works-Building blocks and Major components of block chain-Hyper ledger Fabric Model and architecture.

Crypto Currencies Bit Coin: Introduction and significance of crypto currency- Different types of crypto currency- Mechanics of Bit Coins-Bit coin scripts-Bit coin blocks and networks- status, tools, software's for crypto currencies- crypto currency applications.

Cyber Security: Intrusion Prevention, detection and Management - Firewall -Ecommerce Security - Computer Forensics - Security for VPN and Next Generation Networks; Network security algorithms- Aspects and issues related to cloud storage security, data center security.

Applications, Case Studies & Security Aspects: Application of block chain in health care, land, case studies on bit-coins, case studies on cloud security, data center security, attack prevention, detection and response.

Text Books

1   William Stallings, "Cryptography and Network Security: Principles and
    Practice", 6th Edition, PHI, 2014.
2   Michael E. Whitman and Herbert J Mattord, "Principles of Information Security",
    6th edition, Vikas Publishing House, 2017.

Reference Books

1   Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, "Guide to
    Computer Forensics and Investigations, 4th ed., Thomson Course Technology,

2010.

2   Matt Bishop, "Computer Security: Art and Science", 1st edition, Addison-Wesley
     Professional, 2015.
3   DacNhuong, Jyotir Moy Chetterjee "Cybersecurity in Parallel and Distributed Computing",
     John Wiley & Sons,2018.

Web References

1   https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106106168/lec27.pdf
2   https://nptel.ac.in/courses/106105184/
3   https://blockgeeks.com/guides/what-is-cryptocurrency/
4   https://digitalguardian.com/blog/what-cyber-security
5   https://www.forcepoint.com/cyber-edu/data-center-security

Video Surveillance

Course code: **19EC4075**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understanding of the fundamental concepts related to Video Surveillance.	1,2	3
CO2	Understanding of the feature extraction, pattern analysis visual geometric modelling.	1,2	2
CO3	Vehicle Tracking and Recognition, Human activity recognition	1,2	2
CO4	Applications range from Attribute-based people search, Age estimation from face, Gender recognition from face and body	2,4	2

Syllabus:

Fundamentals: Image feature extraction: Feature point detection, Scale Invariant Feature Transform, Edge Detection, Color features. Multiple View Geometry: Perspective Projection Camera Model, Epipolar Geometry, Probabilistic inference, Pattern recognition and Machine learning: SVM and AdaBoost. Background Modelling and Subtraction: Kernel Density Approximation, Background Modelling and Subtraction Algorithms.

Detection and Tracking: Pedestrian Detection and Tracking: Pedestrian detection by boosting local shape features: Tree learning algorithms, Edgelet features. Occluded pedestrian detection by part combination. Pedestrian tracking by Associating Detection Responses. Vehicle Tracking and Recognition: Joint tracking and Recognition framework, Joint appearance-motion generative model, Inference algorithm for joint tracking and recognition. Human Motion Tracking: Image feature representation, Dimension reduction and Movement dynamics learning.

Activity Detection, Camera Networks & Systems: Human action recognition: Discriminative Gaussian Process dynamic model. Human Interaction recognition: Learning human activity, Track-body Synergy framework; Multi-camera calibration and global trajectory fusion: Non-overlapping and overlapping cameras.

Applications: Smart cities, Biometrics, Gender- Age- Sex Recognition, Challenges, Attribute-based people search, Detection and tracking of Moving Objects.

Text Books

1   Yunqian Ma, Gang Qian, "Intelligent Video Surveillance: Systems and Technology", CRC Press (Taylor & Francis Group), 2010.

2   Anthony C. Caputo, "Digital Video Surveillance and Security", Butterworth-Heinemann, 1st Ed., 2010.

Reference Books

1   Fredrik Nilsson, Communications Axis, "Intelligent Network Video: Understanding Modern Video Surveillance Systems", CRC Press (Taylor & Francis Group), 2008.

Web References

1   https://slideplayer.com/slide/5339696/
2   http://www.fxpal.com/research-projects/video-surveillance/
3   https://www.youtube.com/watch?v=f7PHLx3HoyQ
4   https://www.youtube.com/watch?v=RfmgwOMEMtM

Automated Vehicles & Avionics

Course code: **19EC4081**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basic components of Automotive Electronics	**1,2**	**2**
CO2	Understand the technology involved in autonomous vehicles	**1,2**	**3**
CO3	Analyse the security and control issues	**1,2**	**2**
CO4	Study of applications of modern instruments in Avionics	**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_sensor sim.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

Calibrations and Designing Advanced Instruments

Course code: **19EC4082**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the basics of instruments and calibration.	**1,2**	**2**
CO2	Study of generations of instruments.	**1,2**	**3**
CO3	Understanding the calibration process, methods and certification.	**1,2**	**2**
CO4	Design of advanced instruments with precision, accuracy and 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

Biological & Cyber-Physical Systems

Course code: **19EC4083**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the cyber physical systems and major constituents.	**1,2**	**2**
CO2	Understand and study of various types of cyber physical systems.	**1,2**	**3**
CO3	Study of biological and silicon interfaces.	**1,2**	**2**
CO4	Study of various case studies and miscellaneous topics.	**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

<div align="center">

Electronic Instruments & Biomedical Applications
</div>

Course code: **19EC4084**   L-T-P-S: 3-0-0-0

Pre-requisites : NIL   Credits :3

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BT
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**	**3**
CO3	interpret the basics of Biomedical Electronics,	**1,2**	**2**
CO4	Applications of Bio-medical Electronics (Ex: IoT in healthcare, remote robotic controlled operations, tele-medicine, Medical Electronics Instruments etc.]	**4,2**	**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.   4P
Sensors and measurements: Active and passive transducers, Resistance, inductance and
capacitor measurements. Strain Gauge: LVDT, RTD, Thermistor, thermo couple etc.
6P

**Electronics Instruments and Buses [range of instruments and their 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.   4P
ADC, Signal conditioning, Instrumentation Amplifiers, Digital instruments: Digital
Multimeter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer,
Digital pH meter, Digital capacitance meter. Interfacingbuses.   6P

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.

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	**3**
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	**1**
CO3	To understand the concepts of Automotive Electronics and its evolution and trends. Automotive systems & subsystems overview	1,2	**1**
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	**1**

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 Michae
3	Reinventing the automobile: personal urban mobility for the 21st century (William J. Mitchell, Chris E. Borroni-Bird, Lawrence D. Burns.
4	Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Contro Hall Inc., New Jersey
5	Understanding Automotive Electronics an Engineering Perspective Sevent Ribbens.
6	Automotive Power Transmission Systems Yi Zhang University of Michig Chris MiSan Diego State University USA.
7	Automotive Embedded Systems Handbook CRC Press Taylor & Franc Zurawski
8	Bosch Automotive Electrics and Automotive Electronics Systems a Networking and Hybrid Drive Robert Bosch GmbH (Ed.) 5th Edition
9	William B Ribbens "Understanding Automotive Electronics", SAE Publica Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006.
10	Marc E. Herniter and Zac Chambers: "Introduction to Model Based RoseHulman Institute of Technology. Rudolf Limpert, "Brake design 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
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	3
CO2	Understanding the HMI Technologies such as GMOS Models, CMN-GOMS, Fitts Laws, Hick-Hyman Laws, Norman's 7 Principles.	1,2	1
CO3	Understanding the concept of Brainwaves & BMI	1,2	1
CO4	Analysing Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FEM]	1,2,4	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

19TS4001 – SKILLING FOR ENGINEERS-1

L-T-P-S   : 0-0-0-4   Credits : 1

Pre-requisites   : NIL   Contact Hours : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction to GSD and LabVIEW Environment such as Front Panel, Controls Palette, Controls and Indicators, Block Diagram Terminals, Functions Palette, Data Type, Boolean Operations, String Operations.	1	1
CO2	Introduction to Loop Concept, Nested Loop, Feedback, Arrays, Cluster, Plotting Data using chart and Graph, Tunnel Concept, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes using LabVIEW.	2	2
CO3	Introduction to Case structures, Case Control using Enumerated data type, Introduction to Flat Sequence, Create New Sub VI, Input and Output Sub VI Connectors, Error handling and Debugging Techniques, Introduction to File I/O operations, Event Structure and operations, Design Technique, Introduction to Architecture, Synchronization and Communication using LabVIEW.	2	2
CO4	Introduction to Data Acquisition, Introduction to NI myDAQ; Study of simulate signal express VI and verifying Nyquist theorem; Generating waveform signals; Acquiring generated signal; Build and develop Temperature monitoring system	3	3

Syllabus :Introduction To LabVIEW: Introduction to graphical system design (GSD), working on GSD platform, Benefits of GSD, Text based programming Vs LabVIEW, Introduction to LabVIEW Environment, Front Panel Window Toolbar, Block Diagram Window Toolbar, Introduction to VIs, Data types, Data Representation, Coercion dot, Selecting a Tool, Shortcut Keys, Basic debugging techniques, Introduction to Digital Electronics, Boolean operations , Digital Circuit design, string operations, Various Display Types (Normal, code, Password, HEX display), Exploring string functions Graphical Programming using LabVIEW: Introduction to loop concept, Type of

Loops, For loop, Nested For loop, While loop(Stop if true and Continue if True), hybrid nested loop, Feedback Node, Shift Register and Stack Shift register, Introduction to tunnel and its type, Auto-Indexing, Last Value, Concatenating, Introduction to Arrays, operations of Array Functions, 1-D Array, 2-D Array, Introduction to Clusters, Cluster Function, Difference between Array and Cluster, Chart, Graph, Difference between Chart and Graph by Execution Exercise, Signal Generation and Plotting, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes, Structures Using LabVIEW: Introduction to Case structures, Case Control using Enumerated data type, Enum with type definition, Introduction to Flat Sequence, Create New Sub VI from Scratch, Input and Output Sub VI Connectors, Icon Editor, Making Sub VI from existing VI, Using Sub VIs Exercises, Finding Errors, Error handling and Debugging Techniques. File I/O: Introduction to File I/O, Reading a Data from file, Writing a Data to file, Understanding File I/O using RefNum, File I/O Function Pallet, Introduction to Event Structure and operations, Design Technique, Introduction to Architecture, State machine Architecture. Synchronization and Communication: producer and consumer (Multiple Loops/Parallel programming), Master Slave Architecture Exercises, Difference between Producer Consumer and Master Slave Architecture. Introduction to Data Acquisition, Introduction to NI myDAQ; Study of simulate signal express VI and verifying Nyquist theorem; Generating waveform signals; Acquiring generated signal; Build and develop Temperature monitoring system

Text Books :"Hands-On Introduction to LabVIEW for Scientist and Engineers", John Essick, OXFORD University Press, Second Edition. "Circuit Analysis with MultiSim" DavidBaez-Lopez & Felix E. Guerrero- Castro, Morgan & Claypool Publisher.

Reference Books :"LabVIEW for Everyone", J. Travis &Jim Kring, PRENTICE Hall , Third Edition. "Introduction to MultiSim", Nilsson& Riedel, 9th Edition

Web Links :http://www.ni.com/academic/students/learn-labview/
https://www.youtube.com/playlist?list=PLmdbvGjzIE-EOLHC-RHeUmO1W7v_YuKAX

19TS4002 – SKILLING FOR ENGINEERS-2

L-T-P-S   : 0-0-0-4   Credits : 1

Pre-requisites   : NIL   Contact Hours : 4

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Introduction to GSD and LabVIEW Environment such as Front Panel, Controls Palette, Controls and Indicators, Block Diagram Terminals, Functions Palette, Data Type, Boolean Operations, String Operations.	1,2	1
CO2	Introduction to Loop Concept, Nested Loop, Feedback, Arrays, Cluster, Plotting Data using chart and Graph, Tunnel Concept, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes using LabVIEW.	2	2
CO3	Introduction to Case structures, Case Control using Enumerated data type, Introduction to Flat Sequence, Create New Sub VI, Input and Output Sub VI Connectors, Error handling and Debugging Techniques	1,2	2
CO4	Introduction to File I/O operations, Event Structure and operations, Design Technique, Introduction to Architecture, Synchronization and Communication using LabVIEW.	2,3	2

Syllabus :Introduction To LabVIEW: Introduction to graphical system design (GSD), working on GSD platform, Benefits of GSD, Text based programming Vs LabVIEW, Introduction to

LabVIEW Environment, Front Panel Window Toolbar, Block Diagram Window Toolbar, Introduction to VIs, Data types, Data Representation, Coercion dot, Selecting a Tool, Shortcut Keys, Basic debugging techniques, Introduction to Digital Electronics, Boolean operations , Digital Circuit design, string operations, Various Display Types (Normal, code, Password, HEX display), Exploring string functions Graphical Programming using LabVIEW: Introduction to loop concept, Type of Loops, For loop, Nested For loop, While loop(Stop if true and Continue if True), hybrid nested loop, Feedback Node, Shift Register and Stack Shift register, Introduction to tunnel and its type, Auto-Indexing, Last Value, Concatenating, Introduction to Arrays, operations of Array Functions, 1-D Array, 2-D Array, Introduction to Clusters, Cluster Function, Difference between Array and Cluster, Chart, Graph, Difference between Chart and Graph by Execution Exercise, Signal Generation and Plotting, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes, Structures Using LabVIEW: Introduction to Case structures, Case Control using Enumerated data type, Enum with type definition, Introduction to Flat Sequence, Create New Sub VI from Scratch, Input and Output Sub VI Connectors, Icon Editor, Making Sub VI from existing VI, Using Sub VIs Exercises, Finding Errors, Error handling and Debugging Techniques. File I/O: Introduction to File I/O, Reading a Data from file, Writing a Data to file, Understanding File I/O using RefNum, File I/O Function Pallet, Introduction to Event Structure and operations, Design Technique, Introduction to Architecture, State machine Architecture. Synchronization and Communication: producer and consumer (Multiple Loops/Parallel programming), Master Slave Architecture Exercises, Difference between Producer Consumer and Master Slave Architecture. Introduction to Data Acquisition, Introduction to NI myDAQ; Study of simulate signal express VI and verifying Nyquist theorem; Generating waveform signals; Acquiring generated signal; Build and develop Temperature monitoring system

Text Books :

"Hands-On Introduction to LabVIEW for Scientist and Engineers", John Essick, OXFORD University Press, Second Edition. "Circuit Analysis with MultiSim" DavidBaez-Lopez & Felix E. Guerrero- Castro, Morgan & Claypool Publisher.

Reference Books :

"LabVIEW for Everyone", J. Travis &Jim Kring, PRENTICE Hall , Third Edition. "Introduction to MultiSim", Nilsson& Riedel, 9th Edition

Web Links :
http://www.ni.com/academic/students/learn-labview/
https://www.youtube.com/playlist?list=PLmdbvGjzIE-EOLHC-RHeUmO1W7v_YuKAX

19TS4003 – SKILLING FOR ENGINEERS-3

L-T-P-S   : 0-0-0-4   Credits : 1

Pre-requisites : NIL   Contact Hours : 4

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 :

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.

VLSI Design:

1. Introduction to EDA tools. (Front End – Xilinx/Vivado, Back End – Tanner/Mentor graphics).2.CMOS circuit design.3.Design and verify the functionality of CMOS Logic gates. (Front End).4.Design and verify the functionality of Boolean expression. (Front End).5.Design and verify the schematic and layout of CMOS Logic gates. (Back End).6.Design and verify the schematic and layout of Boolean expressions. (Back End).

Robotics:

1. Introduction to Robotics, Arduino / Raspberry pi 2. Key components of Robots – Sensors, Actuators & Controllers.3. Simulation using Matlab / IGUS /Webots.4.Ardunio / Raspberry pi interfacing.5.Simple line following robot.

SIGNAL PROCESSING:

1. Introduction to MATLAB.2.Introduction to Digital Signal Processing.3.Tools of Image Processing using MATLAB. 4.Time Domain Analysis.5.Frequency Domain Analysis.

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. Data Communication:1.Link aggregation.2.VLAN Principle.3.VLAN Routing.4.Configuration of HDLC.5.Configuration of PPP.

Data Computing:

1:Installation of Python and required libraries, Python for Data Science, Python for Data Science Tips, Tricks, & Techniques, Reading, arranging different data in python for experimentation, Data Visualization, Working with files, Working with web data. 2: Machine Learning- Linear regression, Logistic Regression, K-means, PCA, GMM, SVM, Kernelized Support Vector Machines. 3: Artificial Neural Networks: FF-ANN, FB-ANN, Back propagation, Gradient Decent optimization, Naïve Bayes classifier, Gradient boosted decision trees.4: Deep Learning: Deep ANN, RNN, LSTM, CNN, AlexNet, VGG-16, GoogleNet, Dense CNN, ResNet, Graph CNN, Transfer Learning.

BMI:

1.Perform the measurements based on transducers and plot the characteristics.2. Compare performance of variety of electrodes.3.Measurement of Blood Pressure.4.Measurement of pH. 5.Analyze Instrumentation amplifier for biomedical signals.6.Learn pulse oximeter/Diathermy.7. ECG signal acquisition under incorrect electrode placement.8.EEG Acquisition and Frequency components calculation.

Text Books :

VLSI:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentics Hall 2. Bhasker, J., "A VHDL Primer," Pearson India. 3. Volnei A. Pedroni , "Circuit Design and Simulation with VHDL," 2nd Ed. PHI India 4. R. Jacob Baker, H. W. Li, D. E. Boyce, "CMOS, Circuit Design, Layout, and Simulation," Wiley India Pvt. Ltd. 5. Palnitkar, S., "Verilog HDL", 2nd Ed., Pearson Education.

BMI:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003. 2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.

Data Computing:

1:Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media, 2019.

2: Chollet, Francois. Deep learning with Python. Vol. 361. New York: Manning, 2018.

3. Brownlee, Jason. Deep learning with Python: develop deep learning models on Theano and TensorFlow using Keras. Machine Learning Mastery, 2016.

4. Albon, Chris. Machine learning with python cookbook: Practical solutions from preprocessing to deep learning. " O'Reilly Media, Inc.", 2018.

Wireless communications:

1. MIMO-OFDM Wireless Communications with MATLAB by Yong Soo Cho, etc., Wily publishers (2010).

2.MODELING OF DIGITAL COMMUNICATIONSYSTEMS USING SIMULINKbyARTHUR A. GIORDANO & ALLEN H. LEVESQUE, Published by John Wiley & Sons (2015).

RF&Microwave:

1. HFSS User Guide-Ansoft Corporation.

2. Microstrip filters for RF/Microwave Application-Jiasheng hong.

3. Antenna Theory: Analysis and design by Balanis.

4. Microwave and Millimeter wave Technologies: Modern UWB Antennas and Eqiupment- Igorminin

Data Communications:

1.HCIA Routing and Switching (Intermediate level) Certification material.

Reference Books :

VLSI DESIGN:

1. Sung-Mo Kang, Yusuf Liblebici, "CMOS Digital Integrated Circuits," Tata Mc Graw Hill.

2. Weste, N. and Eshraghian, K., "Principles of CMOS VLSI Design –A Systems Perspective", 2nd Ed., Addison Wesley.

3. Wolf, W., "Modern VLSI Design: System on Chip", 2nd Ed., Prentice Hall of India.

BMI:

1. Brownlee, Jason. Deep learning with Python: develop deep learning models on Theano and TensorFlow using Keras. Machine Learning Mastery, 2016.

2.Albon, Chris. Machine learning with python cookbook: Practical solutions from preprocessing to deep learning. " O'Reilly Media, Inc.", 2018.

Web Links :

Robotics:

1. https://vlab.amrita.edu/?sub=62&brch=271 2. http://vlabs.iitkgp.ac.in/mr/index.html Wireless

communications:

 https://www.linkedin.com/learning/learning-matlab-2/welcome?u=89447330
https://www.youtube.com/watch?v=SyKJrrNhPO8 youtube.com/watch?v=9vQLFYmz5yw

19TS4005 – TECHNICAL PROFICIENCY & TRAINING- 1

L-T-P-S   : 0-0-0-4   Credits : 1

Pre-requisites : NIL   Contact Hours : 4

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)	PO3	2
CO4	Applying the domain based tool for project developments which can be used as a product.	PO4	3

Syllabus :

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.

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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. Data Communication:1.Link aggregation.2.VLAN Principle.3.VLAN Routing.4.Configuration of HDLC.5.Configuration of PPP.

Data Computing:

1:Installation of Python and required libraries, Python for Data Science, Python for Data Science Tips, Tricks, & Techniques, Reading, arranging different data in python for experimentation, Data Visualization, Working with files, Working with web data. 2: Machine Learning- Linear regression, Logistic Regression, K-means, PCA, GMM, SVM, Kernelized Support Vector Machines. 3: Artificial Neural Networks: FF-ANN, FB-ANN, Back propagation, Gradient Decent optimization, Naïve Bayes classifier, Gradient boosted decision trees.4: Deep Learning: Deep ANN, RNN, LSTM, CNN, AlexNet, VGG-16, GoogleNet, Dense CNN, ResNet, Graph CNN, Transfer Learning.

BMI:

1.Perform the measurements based on transducers and plot the characteristics.2. Compare performance of variety of electrodes.3.Measurement of Blood Pressure.4.Measurement of pH. 5.Analyze Instrumentation amplifier for biomedical signals.6.Learn pulse oximeter/Diathermy.7. ECG signal acquisition under incorrect electrode placement.8.EEG Acquisition and Frequency components calculation.

Text Books :

VLSI:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentics Hall 2. Bhasker, J., "A VHDL Primer," Pearson India. 3. Volnei A. Pedroni , "Circuit Design and Simulation with VHDL," 2nd Ed. PHI India 4. R. Jacob Baker, H. W. Li, D. E. Boyce, "CMOS, Circuit Design, Layout, and Simulation," Wiley India Pvt. Ltd. 5. Palnitkar, S., "Verilog HDL", 2nd Ed., Pearson Education.

BMI:

 1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003. 2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.

Data Computing:

1:Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media, 2019.

 2: Chollet, Francois. Deep learning with Python. Vol. 361. New York: Manning, 2018.

3. Brownlee, Jason. Deep learning with Python: develop deep learning models on Theano and TensorFlow using Keras. Machine Learning Mastery, 2016.

4. Albon, Chris. Machine learning with python cookbook: Practical solutions from preprocessing to deep learning. " O'Reilly Media, Inc.", 2018.

 Wireless communications:

1. MIMO-OFDM Wireless Communications with MATLAB by Yong Soo Cho, etc., Wily publishers (2010).

 2.MODELING OF DIGITAL COMMUNICATIONSYSTEMS USING SIMULINKbyARTHUR A. GIORDANO & ALLEN H. LEVESQUE, Published by John Wiley & Sons (2015).

RF&Microwave:

1. HFSS User Guide-Ansoft Corporation.

 2. Microstrip filters for RF/Microwave Application-Jiasheng hong.

3. Antenna Theory: Analysis and design by Balanis.

4. Microwave and Millimeter wave Technologies: Modern UWB Antennas and Eqiupment- Igorminin

Data Communications:

1.HCIA Routing and Switching (Intermediate level) Certification material.

Reference Books :

VLSI DESIGN:

1. Sung-Mo Kang, Yusuf Liblebici, "CMOS Digital Integrated Circuits," Tata Mc Graw Hill.

2. Weste, N. and Eshraghian, K., "Principles of CMOS VLSI Design –A Systems Perspective", 2nd Ed., Addison Wesley.

3. Wolf, W., "Modern VLSI Design: System on Chip", 2nd Ed., Prentice Hall of India.

BMI:

1. Brownlee, Jason. Deep learning with Python: develop deep learning models on Theano and TensorFlow using Keras. Machine Learning Mastery, 2016.

2.Albon, Chris. Machine learning with python cookbook: Practical solutions from preprocessing to deep learning. " O'Reilly Media, Inc.", 2018.

Web Links :

Robotics:

1. https://vlab.amrita.edu/?sub=62&brch=271 2. http://vlabs.iitkgp.ac.in/mr/index.html Wireless

communications:

 https://www.linkedin.com/learning/learning-matlab-2/welcome?u=89447330
https://www.youtube.com/watch?v=SyKJrrNhPO8 youtube.com/watch?v=9vQLFYmz5yw