DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAM DEVELOPMENT DOCUMENT FOR B. TECH (ECE) 2018

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

(DEEMED TO BE UNIVERSITY)

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 2018-19 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
L18	Remote Sensing			N18	Telecommunication	G18	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	18UC1101	Basic English	0	0	4	0	2	NIL
2	18UC1202	English Proficiency	0	0	4	0	2	NIL
3	18UC2103	Professional Communication Skills	0	0	4	0	2	NIL
4	18UC2204	Aptitude Builder -1	0	0	4	0	2	NIL
5	18UC3105	Aptitude Builder -2	0	0	4	0	2	NIL
6	18UC3206	Campus to Corporate	0	0	4	0	2	NIL
7	18UC0007	Indian Heritage and Culture*	2	0	0	0	0	NIL
8	18UC0008	Indian Constitution*	2	0	0	0	0	NIL
9	18UC0009	Ecology & Environment*	2	0	0	0	0	NIL
10	18UC0010	Universal Human Values & Professional Ethics*	2	0	0	0	0	NIL
Total Credits							**12**	
II		**BASIC SCIENCES**						
1	18SC1103	Single Variable Calculus and Matrix Algebra	3	0	0	0	3	NIL
2	18MT1201	Multivariate Calculus	3	0	2	0	4	NIL
3	18SC1105	Logic and Reasoning	0	0	2	0	1	NIL
4	18SC1104	Foundations of Computational Mathematics	0	0	2	0	1	NIL
5	18BT1001	Biology for Engineers	2	0	0	0	2	NIL
		SCIENCE ELECTIVE - 1						
1	18PH1005	PHYSICS FOR ELECTRONICS ENGINEERING	3	0	2	0	4	NIL
2	18PH1004	SOLID STATE PHYSICS	3	0	2	0	4	NIL
3	18PH2101	Quantum Mechanics for Engineers	3	1	0	0	4	NIL
		SCIENCE ELECTIVE - 2						
1	18CY1101	ENGINEERING CHEMISTRY	3	0	2	0	4	NIL
2	18CY1003	CHEMISTRY & BIOINFORMATICS FOR ENGINEERS	3	0	2	0	4	NIL
3	18CY1004	ORGANIC ELECTRONICS	3	0	2	0	4	NIL
Total Credits							**18**	
III		**ENGINEERING SCIENCES**						
1	18SC1101	Problem Solving and Computer Programming	3	0	2	0	4	NIL
2	18SC1202	Data Structures	3	0	2	0	4	NIL
3	18EC1002	Engineering Graphics & Design for Electronics and Computer Engineers	0	0	4	0	2	NIL
4	18EE1003	Workshop Practice for Electrical and Electronics Engineers	0	0	4	0	2	NIL
5	18CS2004	Object Oriented Programming	2	0	2	0	3	NIL
6	18EC1101	Digital System Design	3	0	2	0	4	NIL
7	18EC3110	Electronic Workshop-II (Electronic System Design Workshop)	1	0	2	2	2.5	NIL
8	18EC2214	Electronics Workshop-III (IOT Applications)	1	0	0	4	2	18SC1101
9	18EC2115	IT Workshop-I (HTML,XML,WEB DESIGN)	1	0	2	0	2	NIL
10	18EE2105	Electrical Circuit Theory	3	1	0	0	4	NIL

Total Credits							**29.5**	
		PROFESSIONAL CORE COURSES						
1	18EC1202	Computer Organization & Architecture	3	0	0	0	3	NIL
2	18EC2103	Analog Electronic Circuit Design	3	0	2	0	4	NIL
3	18EC2104	Communications Signals and System Design	3	1	0	0	4	NIL
4	18EC2205	Embedded Controllers	2	0	3	2	4	NIL
5	18EC2206	Analog and Digital Communication	3	0	3	0	4.5	NIL
6	18EC2207	Digital Signal Processing	3	0	2	0	4	NIL
7	18EC3109	Date Networks and Protocols	3	0	2	0	4	NIL
8	18EC2112	Electromagnetic Fields and Applications	3	1	0	0	4	NIL
9	18EC2213	Statistics, AI, ANN-Basic Course	3	0	0	2	3.5	NIL
10	18EC2222	Introduction to Ai & ANN Tools and Applications	3	0	0	0	3	NIL
Total Credits							**35**	
SKILLING COURSES								
1	18SC1106	Technical Skill - 1 (Coding)	0	0	0	6	1.5	NIL
2	18SC1207	Technical Skill - 2 (Coding)	0	0	0	6	1.5	NIL
3	18TS401	SKILLING FOR ENGINEERS-1 (IT CODING/HARDWARE CODING)	0	0	0	6	1.5	NIL
4	18TS402	SKILLING FOR ENGINEERS-2 (IT CODING/TECHNICAL SKILLING)	0	0	0	6	1.5	NIL
5	18TS403	SKILLING FOR ENGINEERS-3 (IT CODING/TECHNICAL SKILLING)	0	0	0	4	1	NIL
6	18TS404	SKILLING FOR ENGINEERS-4 (IT CODING/TECHNICAL SKILLING)	0	0	0	4	1	NIL
7	18TS405	Technical Proficiency & Training -1	0	0	0	4	1	NIL
8	18TS406	Technical Proficiency & Training -2	0	0	0	4	1	NIL
Total Credits							**10**	
TERM PAPER & PROJECT								
1	18IE2246	INDUSTRIAL TRAINING	0	0	4	0	2	NIL
2	18IE3247	TERM PAPER	0	0	4	0	2	NIL
3	18IE4048	PROJECT (PART I)	0	0	0	24	6	NIL
4	18IE4049	PROJECT (PART II)	0	0	0	24	6	NIL
5	18IE4050	PRACTICE SCHOOL	0	0	0	24	6	NIL
6	18IE4051	INTERNSHIP	0	0	0	24	6	NIL
7	18PR3080	MID-GRADE CAPSTONE PROJECT	0	0	4	0	2	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**	
COUNSELLING & CO CIRCULAR ACTIVITY								
1	18GN1101	Counseling -1	0	0	1	0	0	NIL
2	18GN1202	Counseling -2	0	0	1	0	0	NIL
3	18GN2103	Counseling -3	0	0	1	0	0	NIL
4	18GN1107	Cocurricular Activity -1	0	0	0	2	0.5	NIL
5	18GN1208	Cocurricular Activity -2	0	0	0	2	0.5	NIL
6	18GN2109	Cocurricular Activity -3	0	0	0	2	0.5	NIL
Total Credits							**1**	
Grand Total Credits							**167**	

S.No	Course Code	Course Name	CO No.	CO	PO												PSO	
					1	2	3	4	5	6	7	8	9	10	11	12	1	2
I	HUMANITIES & SOCIAL SCIENCES																	
1	18UC1101	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	18UC1202	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				

			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	18UC2103	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									
4	18UC2204	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	18UC3105	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				
			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	18UC3206		1	Analyze basic concepts of critical and analytical reasoning skills apply strategies to					3	3			3					

				analyze issues, arguments and some aspects of corporate communication.														
			2	Creativity in writing of any given context like sending Emails, Reports, Proposals etc. Make the student to face HR interviews.							3	3		3				
		CAMPUS TO CORPORATE	3	Apply the concepts of Arithmetic, the students enhance their problem solving skills which helps them to succeed in campus drives, grooming the young learners into the corporate world.	3			3	3									
			4	Analyze the basic concepts of Critical and Analytical Reasoning in meeting the challenges of the professional world.	3				3									
7	18UC0007	*INDIAN HERITAGE AND CULTURE	1	To familiarize with various aspects of the culture and heritage of India through ages.	1													
			2	To acquaint with the contributions of Indians in the areas of languages and literature, religion and philosophy	1													
			3	To understand the Social structure and the spread of Indian culture abroad	1													
			4	To know the development of Science and Technology in India through ages and to appreciate the contributions of some of the great Indian scientists	1													
8	18UC0008	*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		
9	18UC0009	*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								
10	18UC0010	*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	18SC1103	Single Variable Calculus and Matrix Algebra	1	Model the physical laws and relations mathematically as a first order differential equations, solve by analytical and numerical methods also interpret the solution.	1													
			2	Model physical laws and relations mathematically as a second/higher order differential equations, solve by analytical method and interpret the solution.	1													

			3	Obtain the Fourier series expansions of periodic functions and use the series to solve ordinary differential equations.	1													
			4	Model physical problems mathematically as a system of linear equations and solve them by analytical and numerical methods. Also, determine the nature of Quadratic form using Eigen values.		1												
2	18MT1201	Multivariate Calculus	1	Determine extreme values for functions of several variables	1													
			2	Determine area, volume moment of inertia through multiple integrals in Cartesian or polar co-ordinates.	2													
			3	Apply the concepts of vector calculus to calculate the gradient, directional derivative, arc length, areas of surfaces and volume of solids in practical problems	2													
			4	Obtain analytical and numerical solutions of Heat and wave equations	2													
			5	Verify the solution of problems through MATLAB											3			
3	18SC1105	Logic and Reasoning	1	Understand how to use Venn diagrams to find the conclusion of statements, solve puzzles using binary logic.	1													
			2	Understand to solve problems on clocks, calendars and problems on Non verbal reasoning.	1													
			3	Understand the available models for Venn diagrams with given data, solve problems relating to cubes and number and letter series.	1													

			4	Understand the techniques used to solve problems puzzles using analytical reasoning on coding and decoding and blood relations	1													
4	18SC1104	Foundations of Computational Mathematics	1	Identify the quantities of Real world problems by using the concepts of arithmetic.	1													
			2	Computing the areas of regular and irregular solids of real world problems.	1													
			3	Identifying the numbers by successive division also finding the solution of equations.	1													
			4	Estimating the roots of an equations and find the unknown values from the data by numerical methods	1													
6	18BT1001	Biology for Engineers	1	Understand the basis of Life, Living organisms and human body systems	2		2	2				2						
			2	Understand the importance of Diet and Nutrition	2		2	2				2						
			3	Acquire the knowledge of beneficial and harmful Microorganisms and Biosensors	2		2	2				2						
			4	Understand the importance of Biosensors	2		2	2				2						
	SCIENCE ELECTIVE-I																	
1	18PH1005	PHYSICS FOR ELECTRONIC ENGINEERS	1	Ability to understand classification of solids based on their Energy Bands.	1						1							
			2	Ability to understand the conducting and semiconducting properties of solids at the microscopic level.	1						1							

			3	Ability to understand the dielectric properties of materials at the microscopic level and their applications.	1						1							
			4	Ability to understand the magnetic interactions in materials and the applications.	1						1							
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects							1							
2	18 PH1004	SOLID STATE PHYSICS	1	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	1						1							
			2	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering applications.	1						1							
			3	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	1						1							
			4	Understands the role of electronic energy band structures of solids using various models, classification of materials based on their band structures and their properties	1						1							
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	1						1							

3	18PH2101	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													
			5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.							2							
	SCIENCE ELECTIVE-II																	
4	18CY1001	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
5	18CY1003		1	Develop the current knowledge of materials and apply the characteristics, theories of materials in biomedical applications.	1				1	1							1	1

		Chemistry and Bio-Informatics for Engineers	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	18CY1004	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	18SC1101	Problem Solving and Computer Programming	1	Illustrate how problems are solved using computers and programming.	1	1													
			2	Illustrate and use Control Flow Statements in C.	1	1													

			3	Interpret & Illustrate user defined C functions and different operations on list of data.	1	1												
			4	Implement Linear Data Structures and compare them.				1										
2	18SC1202	Data Structures	1	Apply measures of efficiency on algorithms and Analyze different Sorting Algorithms.	1	1												
			2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	1			1										
			3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.		2		2										
			4	Analyse different representations, traversals, applications of Graphs and Heap organization.	1	1												
3	18EC1002	Engineering Graphics & Design for Electronics and Computer Engineers	1	Describe some important design considerations in choosing a graphics for a specific application.	2		2				2							
			2	Acquire knowledge on orthographic projection	2		2											
			3	Examine projections of planes and solids	2						2							
			4	Explain the role of curves and sections	2						2							
			5	Analyze & generate PCB layout skills	2			2										
4	18EE1003	Work Shop Practice for Electrical and Electronics Engineers	1	Prepare wooden Lap T, Plus joints. Prepare square and L fits. Fabricate parts made of sheet metal. Demonstrate the ability to execute stair-case lighting and godown lighting house wiring connections												3		
			2	Use arc welding equipment and tools to prepare butt joint for joining mild steel metal flats in a safe manner. Demonstrate the ability to melt and pour molten material into dies. Perform facing and plain turning on Lathe to prepare cylindrical jobs. Drill												3		

				holes on Mild steel metal flats using drilling machine.														
			3	Identify hardware components in a computer system, Assemble and disassemble a computer system, Install operating system and software												3		3
			4	Identify electronics components& soldering practice, connect identified computers in a network,												3		3
5	18CS2004	Object Oriented Programming	1	The student will be able to understand basic Concepts of OOP, fundamentals of java and apply the concepts of classes and objects through Java Language.	2	2												
			2	The student will be able to apply constructors, Overloading, parameter passing, in Java programming.	2	2												
			3	The student will be able to apply access control, Inheritance, Packages.	2	2												
			4	The student will be able to apply , Interfaces, Exception Handling	2	2												
			5	Students will be able to apply object oriented programming concepts to write programs.	2	2												
6	18EC1101	Digital System Design	1	Describe the concepts of number systems with codes and logic gates usage in digital circuit design and identify the logical expressions in different forms and their minimization techniques for logical circuit optimization	2													
			2	Employ Combinational logic circuits with minimization techniques and logical verification through hardware description language					3								3	
			3	Substantiation of Sequential logic circuits and logical verification through hardware description language					3								3	
			4	Implementation of digital circuits using PAL, PLA, FPGA and CPLD					4									

			5	Analyse the digital IC logic for combinational and sequential circuits implementation						4								
7	18EC3110	Electronic Workshop-II (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	Able to understand PCB fabrication process, PCB artwork and various protection methods for electronic systems.	2		2		2		2							
			3	Able to understand Raspberry Pi microcontroller and its applications	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									
			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.											4			
8	18EC2214	Electronic Workshop-III (IOT Applications)	1	IoT Applications & Sensors: Analog & Digital sensors, MPU 6050, MCP2515(CAN), DS3231(RTC), Applications					2									
			2	nterfacing to IoT : Micro controllers boards, ESP8266, Peripherals (Motors, Camera, Speaker, Displays), Controlling through Mobile & Web			2											
			3	IoT Data Communication: Wi-Fi Protocols, Bluetooth, BLE, WSN, Zigbee, RFID, NFC, Client Server, Cloud.										2				
			4	Protocols & Case Studies : Issues & Challenges : Security, Privacy, Scalability, Store and Analytics Case Studies: Health, Smart cities, Village/ Agriculture							2							
			5	01: BASIC LED BLINKING,02: GAS DETECTING SENSOR USING NODEMCU,03: PRESSURE SENSOR,04: SERVO MOTOR WITH ESP32,5.SERVO MOTOR CONTROL WITH BLUETOOTH,06: GREETINGS MESSAGE THROUGH WEBPAGE WITH ESP AS SERVER,07 : SERVO MOTOR CONTROL WITH WEBPAGE,08: TEMPERATURE AND HUMIDITY										3			

				MONITORING IN CLOUD PLATFORM,WIFI WEATHER STATION TOOL AND ANALYSIS,10: TEMPERATURE AND HUMIDITY MONITORING WITH RASPBERRY Pi AND SERVO MOTOR,11: DIRECTION CONTROL OF A 3D														
9	18EC2115	IT Workshop-I (HTML, XML, WEB DESIGN)	1	Experiment with HTML/XML and Word press		3	3											
			2	Construct Arduino Interfacing and Mobile Apps (Native apps for Android Phone)			3	3										
			3	Experiment with interfacing the Raspberry Pi board with Web-App, and develop similar applications for Mobile App			3		3									
			4	Develop Project using Raspberry pi based controlled with Web Apps or Mobile Apps						3								
10	18EE2105	Electrical Circuit Theory	1	Understand the circuit elements and AC fundamentals for electrical networks	1				1								1	
			2	Apply Network theorems to Electrical networks (AC & DC)	1				2									1
			3	Analyse the Two port networks, Resonance & Transients	2				2									1
			4	Understand the Magnetic circuits and fundamental laws of electromagnetic induction	1				1								1	
IV	**PROFESSIONAL CORE COURSES**																	
1	18EC1202	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	18EC2103	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	18EC2104	COMMUNICATION SIGNALS & SYSTEM DESIGN	1	Ability to represent Analog signal(s) as mathematical function(s) and manipulate them into more desirable function(s) by using the several available mathematical operations. Understand the three types of system representation. Ability to compute the response of the system for any given input and impulse-response function.	3					2							1	1
			2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	3		2										1	1
			3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	3	3						2					1	1
			4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain												2	1	1

4	18EC2205	EMBEDDED CONTROLLERS	1	Understand the architecture and programming concepts of 8086 Microprocessor	1	2												
			2	Apply the Programming concepts of 8051 Microcontroller					1									
			3	Analyze the Interfacing of Peripherals to the 8051 microcontrollers through programming. Understand the basic architectures of PIC and ARM 7 microcontrollers			3											
			4	Understand the basic concepts of CORTEX STM-32 microcontroller and RTOS		2												
			5	Analyze the applications of programming with 8051 and 8086 on hardware / software. Analyze the applications of programming with Arduino					1									
5	18EC2206	ANALOG AND DIGITAL COMMUNICATION	1	Analyze the linear and nonlinear 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									
6	18EC2207	DIGITAL SIGNAL PROCESSING	1	Understand the Analysis of FFT & Wavelets	1	2												
			2	Explore and Design the Digital filters: Digital FIR		2												

			3	Analysis and Design the Digital filters: Digital IIR		2												
			4	Understand and apply multi-rate signal processing, interpolation, and decimation concepts			3											
			5	Design and Analysis of LTI Systems and Filters			3											
7	18EC3109	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									
8	18EC2112	ELECTROMAGNETIC FIELDS & APPLICATIONS	1	Understanding the basics of EM fields and magnetic fields	3	1												
			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												
9	18EC2213	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											
10	18EC2222	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												
			4	To Implement AI and ANN Models for real time problems	2	2												
V	**FLEXI COURSES**																	
1	18EC2208	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	18EC4111	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	18EC3016	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												
			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	18EC3017	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	18EC3018	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	18EC3019	SYSTEM ENGINEERING, OPERATION RESEARCH & DESIGNING	1	Introduction to the concepts and techniques of system design	1	2												
			2	Understand the basic of operation research	2	2												
			3	Understand and application of design objectives, industry & market forces and product design strategies	2	2												
			4	Understand and analyze the product design goals, methodologies.	2	2												
7	18EC3020	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	18EC3021	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 PROFESSIONAL ELECTIVES**																	
ESS 1	**EMBEDDED CONTROLLERS, IOTS & POWER ELECTRONICS**																	
1	18EC3051	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	18EC3052	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	18EC3053		1	Study of Renewable Energy and types with solar power and electronic power converters.	3	1												

		Electronic Systems for Renewable Energy & Smart Grid	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	18EC3054	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	18EC3055	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												
ESS 2	**VLSI & MICRO - ELECTRONICS**																	
1	18EC3061	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	18EC3062	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	18EC3063	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			
			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	18EC3064	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	18EC3065	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	18EC3066	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											
ESS 3	**AUTOMATION & ROBOTICS**																	
1	18EC3071	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	18EC3072	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												
3	18EC3073	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	18EC3074	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	18EC3075	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												
6	18EC3076	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												
ESS 4	**SIGNAL PROCESSING**																	
1	18EC3081	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	18EC3082	Digital Image Processing	1	Acquire the fundamental concepts of a digital image processing system			3											
			2	Identify and exploit analogies between the mathematical tools used for 1Dand 2D signal analysis and processing by analysing 2D signals in the frequency domain through the Fourier transform			1		1									
			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	18EC3083	Biomedical Image Analysis	1	Fundamentals of Digital image	1	1												
			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	18EC3084	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	18EC3085	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	18EC3086	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	18EC3087	Biomedical Signal Analysis	1	Basics	1	1												
			2	Modalities, Signal Processing Methods	1	1												

			3	Modern Biomedical Technologies & Instruments	1	1													
			4	Advanced Applications		1	1												
ESS 5	**COMMUNICATION & WIRELESS**																		
1	18EC3091	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	18EC3092	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	18EC3093	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	18EC3094	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	18EC3095		1	5G New Radio	1	1	1	1	1										

		Next Generation Wireless Technologies	2	Massive MIMO for 5G and Beyond 5G	1	1	1	1	1									
			3	Millimeter wave Communications	1	1	1	1	1									
			4	Vehicular Communications and other Advanced Topics	1	1	1	1	1									
ESS 6	**DATA COMMUNICATION & NETWORKS**																		
1	18EC4051	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	18EC4052	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	18EC4053	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	18EC4054	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									
			3	Understand the concept of Cloud-Computing and Security			1	1	1									
			4	Analysis of various Network Security issues	1	1												
5	18EC4055	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												
ESS 7	**RF, MICROWAVE & RADARS**																	
1	18EC4061	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	18EC4062	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	18EC4063	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												
			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	18EC4064	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	18EC4065	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											
ESS 8	**AI & ML**																	
1	18EC4071	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	18EC4072	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	18EC4073	Pattern Recognition	1	Understand basic concepts in pattern recognition	1	3												
			2	Understanding Generative Learning Models	1	2												
			3	Analyze the structured pattern recognition	1		2											
			4	Apply pattern recognition techniques in practical problems.		1		2										
4	18EC4074	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	18EC4075	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										
ESS 9	**BIO-MEDICAL INSTRUMENTATION**																	

1	18EC4081	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	18EC4082	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												
3	18EC4083	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	18EC4084	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										

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	18UC1101	BASIC ENGLISH	2				2					2				
2	18UC1202	ENGLISH PROFICIENCY	2			2	2			2	2	2				
3	18UC2103	PROFESSIONAL COMMUNICATION SKILLS	2				2			2	2	2				
4	18UC2204	APTITUDE BUILDER-I	2				2	2	2			2				
5	18UC3105	APTITUDE BUILDER-II	1				2			2		2				
6	18UC3206	CAMPUS TO CORPORATE	3			3	3	3	3	3	3	3				
7	18UC0007	*INDIAN HERITAGE AND CULTURE	1													
8	18UC0008	*INDIAN CONSTITUTION												2		
9	18UC0009	*ECOLOGY & ENVIRONMENT						1						2		
10	18UC0010	*UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS (ONLINE)								1						
*Note: * marked course are audit courses*																
II	**BASIC SCIENCES**															
1	18SC1103	Single Variable Calculus and Matrix Algebra	1	1												
2	18MT1201	Multivariate Calculus	2										3			
3	18SC1105	Logic and Reasoning	1													
4	18SC1104	Foundations of Computational Mathematics	1													
6	18BT1001	Biology for Engineers	2		2	2				2						
SCIENCE ELECTIVE-1																
1	18PH1005	PHYSICS FOR ELECTRONIC ENGINEERS	1						1							
2	18 PH1004	SOLID STATE PHYSICS	1						1							
3	18PH2101	QUANTUM MECHANICS FOR ENGINEERS	2						2							
SCIENCE ELECTIVE-2																

4	18CY1101	ENGINEERING CHEMISTRY	1	1	1	1	1	1	1						1	1
5	18CY1003	Chemistry and Bio-Informatics for Engineers	1		1		1	1							1	1
6	18CY1004	Organic Electronics	1	1	1	2	1	1	1						1	1
III	ENGINEERING SCIENCES															
1	18SC1101	Problem Solving and Computer Programming	1	1		1										
2	18SC1202	Data Structures	1	2		2										
3	18EC1002	Engineering Graphics & Design for Electronics and Computer Engineers	2		2	2			2							
4	18EE1003	Workshop Practice for Electrical and Electronics Engineers												3		3
5	18SC2004	Object Oriented Programming	2	2												
6	18EC1101	Digital System Design	2				4	4							3	
7	18EC3110	Electronic Workshop-II (Electronic System Design Workshop)	2		2		2		2			4				
8	18EC2214	Electronics Workshop-III (IOT Applications)			2		2		2			2				
9	18EC2115	IT Workshop-I (HTML,XML,WEB DESIGN)		3	3	3	3	3								
10	18EE2105	Electrical Circuit Theory	2				2								1	1
IV	**PROFESSIONAL CORE COURSES**															
1	18EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	1	2	1											
2	18EC2103	ANALOG ELECTRONIC CIRCUIT DESIGN	3		2		2									
3	18EC2104	COMMUNICATION SIGNALS & SYSTEM DESIGN	3	3	2			2		2				2	1	1
5	18EC2205	EMBEDDED CONTROLLERS	1	2	3		1									
4	18EC2206	ANALOG AND DIGITAL COMMUNICATION	1		3		2									
7	18EC2207	DIGITAL SIGNAL PROCESSING	1	2	3											
9	18EC3109	DATA NETWORKS AND PROTOCOLS	1	2			1									
6	18EC2112	ELECTROMAGNETIC FIELDS & APPLICATIONS	3	1												
8	18EC2213	STATISTICS, AI, ANN-Basic course	3	3	2											
10	18EC2222	INTRODUCTION TO AI, ANN TOOLS & APPLICATIONS	2	2												
V	**FLEXI COURSES**															

1	18EC2208	VLSI DESIGN	3	2			1										
2	18EC4111	WIRELESS COMMUNICATIONS	1	3	1	2	1	1									
3	18EC3016	RF SYSTEM DESIGN	1	1	3	3											
4	18EC3017	BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE	1	2	1	2	2										
5	18EC3018	ELECTRONICS INSTRUMENTS & AUTOMATION	3	1	2	1											
6	18EC3019	SYSTEM ENGINEERING, OPERATION RESEARCH & DESIGNING	2	2													
7	18EC3020	ELECTRICAL TECHNOLOGIES & SOLAR POWER SYSTEMS	1	2	3	2											
8	18EC3021	ADVANCE COURSE IN SOFT-COMPUTING (AI, ANN, FUZZY LOGIC & GENETIC ALGORITHMS)	1	3	2	3											
VI	**LIST OF PROFESSIONAL ELECTIVES**																
ESS1	**EMBEDDED CONTROLLERS, IOTS & POWER ELECTRONICS**																
1	18EC3051	Wireless sensor Networks & IOT Applications	3	1		1											
2	18EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	3	1		1											
3	18EC3053	Electronic Systems for Renewable Energy & Smart Grid	3	1		1											
4	18EC3054	IOT Applications for Smart Cities	3	1	1												
5	18EC3055	Systems for Smart Cities & Smart Villages	1	1													
ESS2	**VLSI & MICRO - ELECTRONICS**																
1	18EC3061	Low Power VLSI	3	1	1												
2	18EC3062	Algorithms for VLSI Design Automation	1	1	1			1									
3	18EC3063	ASIC and FPGA Chip Design	3		1								1				
4	18EC3064	VLSI Sub-system Design and Design for Testability	3		1		1										
5	18EC3065	Semiconductor Memories & MEMS	3	1	1												
6	18EC3066	Analog & Digital IC Applications	3	1	1												
ESS3	**AUTOMATION & ROBOTICS**																
1	18EC3071	Control Systems & Introduction to Robotics	3	1													

2	18EC3072	Autonomous Vehicles & Automotive Electronics	3	1												
3	18EC3073	Advanced Robotics	3	1												
4	18EC3074	Computer Vision & Applications	3	1												
5	18EC3075	Human Machine Interface & Brain Machine Interface	3	1												
6	18EC3076	Designing Automation Systems & Assistive Robotic Systems	3	1												
ESS4	**SIGNAL PROCESSING**															
1	18EC3081	Speech Signal Processing		1			1									
2	18EC3082	Digital Image Processing			3		1									
3	18EC3083	Biomedical Image Analysis	1	1		1										
4	18EC3084	Statistical Signal Processing	1	1		1										
5	18EC3085	Adaptive Signal Processing	1	1		1										
6	18EC3086	Detection and Estimation of Signals	1	1		1										
7	18EC3087	Biomedical Signal Analysis	1	1	1											
ESS5	**COMMUNICATION & WIRELESS**															
1	18EC3091	Information Theory & Coding	1	1	1	1	1									
2	18EC3092	4G Wireless Technologies and Cellular Communication	1	1	1	1	1									
3	18EC3093	Satellite Communications	1	1	1	1	1									
4	18EC3094	Optical Communication	1	1	1	1	1									
5	18EC3095	Wireless Technologies (WCDMA, GPRS, GSM, UMTS)	1	1	1	1	1									
ESS6	**DATA COMMUNICATION & NETWORKS**															
1	18EC4051	TCP/IP & Other Protocol Suite	1	1	1	1	1									
2	18EC4052	VoIP Systems & Broad Band Networks	1	1	1	1	1									
3	18EC4053	5G Mobile, Wireless Technologies & IEEE 802 Standards	1	1	1	1	1									
4	18EC4054	Cloud-Computing & Network Security	1	1	1	1	1									
5	18EC4055	IP Multimedia Sub-System & Emerging Technologies (Cloud, IOT, NFV, SDN)	1	1	1	1	1									
ESS7	**RF, MICROWAVE & RADARS**															

1	18EC4061	Microwave Engineering	1	3	1												
2	18EC4062	Antenna Design & Wave Propagation	1	3			1										
3	18EC4063	Radar Engineering & Navigational Aids	1	3	1												
4	18EC4064	Modern Antennas, Millimeter Waves & Applications	1	3	1												
5	18EC4065	Electronic Warfare, EMI & EMC	1	3	1												
ESS8	**AI & ML**																
1	18EC4071	Machine Learning	1	3		2											
2	18EC4072	Data Sciences & Big-Data	1	3	2	2											
3	18EC4073	Pattern Recognition	1	3	2	2											
4	18EC4074	Block-Chain & Cyber Security	1	3	2	2											
5	18EC4075	Video Surveillance	1	3		2											
ESS9	**BIO-MEDICAL INSTRUMENTATION**																
1	18EC4081	Automated Vehicles & Avionics	1	3													
2	18EC4082	Calibrations and Designing Advanced Instruments	1	3													
3	18EC4083	Biological & Cyber-Physical Systems	1	3													
4	18EC4084	Electronic Instruments & Biomedical Applications	1	3		2											

(DEEMED TO BE UNIVERSITY)

SYLLABUS A.Y. 2018-18

HUMANITIES AND SOCIAL SCIENCES

BASIC ENGLISH

Course Code: 18UC1101 **L-T-P-S: 0-0-4-0**

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of grammar, students will improve their communication, reading, and writing skills	**10**	2
CO2	Apply the concepts, students will improve their reading, and writing skills	**10**	2
CO3	Apply the concept of fundamental principles to solve the problems on linear equations, quadratic equations. Apply the concept of progressions while doing problems on progressions and mensuration and also problems on finding volume and surface areas.	**1**	2
CO4	Analyze the given conditions and finding out the directions, problems related to symbols and notations, numbers or letters. Analyze 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.	**5**	2

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- ise.
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.

Text 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

Reference Books

3. R.K. Bansal, J.B. Harrison: *Spoken English*. Delhi: Orient Black Swan.2009.
4. Language Laboratory Teacher Manual, KLEFU.

ENGLISH PROFICIENCY

Course Code: 18UC1202 **L-T-P-S: 0-0-4-0**

CO#	Course Outcome	PO/PSO	BTL
CO1	Identify the structure and usage of phrases, clauses and sentences along with the techniques of learning vocabulary, concord and sentence equivalence and apply the strategies in different contexts.	8,9,10	2
CO2	Identify formats and parameters of writing skills and apply in product and process descriptions.	8,9,10	2
CO3	Apply the methods of fundamental concepts of tabulation, line-graphs, bar-graphs and pie charts in Data Interpretation and statements in Data Sufficiency	1,4	2
CO4	Identify the basic symbols and notations to find out the hidden analogy to solve sequences	1,5	2

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 Interactives:** 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.

Text Books:

1. Dictionary of Technical Terms
2. Dr. Meenakshi Raman and Dr. Sangeetha Sarma: *Technical Communication*.Oxford University Press: Delhi.2016.
3. The Ultimate Verbal and Vocabulary Builder. Texas: Lighthouse Review.2000.

Reference Books:

4. Rajeev Vasisth: *Interactive Vocabulary Drills*. New Delhi: Arihant Publications Limited. 2011.
5. Language Laboratory Teacher Manual, KLEFU

PROFESSIONAL COMMUNICATION SKILLS

Course Code: 18UC2103 **L-T-P-S: 0-0-4-0**

CO#	Course Outcome	PO/PSO	BTL
CO1	Identify the structure of sentences with the techniques of Etymology and apply in everyday conversations. Able to write Paragraphs, Letters, have the knowledge of Sentence completion and the Creativity	9,10	2
CO2	Identify and Develop Inter-personal Communication skills and Cultural Sensitivity and apply them in the Corporate world to secure the best jobs in the industry	8	2
CO3	Apply the Arithmetic concepts Time & Work and Time & Distance	1	2
CO4	Understand the techniques used to take decision making based on data, understanding the logical connectives and implications, data analysis of by using Venn diagrams	1,5	2

Syllabus:

Grammarand 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

Text 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

Reference Books:

3. GeraldJ Alfred, Charles T Brusaw and Walter E.Oliu. Hand Book of Technical Writing. USA:Betford.2000.
4. Asher Cashdan: *Language, Reading and Learning.* Oxford:Basil Blackwell.1879.

APTITUDE BUILDER –I

Course Code: 18UC2204 **L-T-P-S: 0-0-4-0**

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the importance of business correspondence and utilize proper format, content and tools for improved results.	5,6	2

CO2	Conduct of conferences and customer handling more efficiently with the application of relevant business etiquette.	7,10	2
CO3	Understand the properties of numbers, solving the problems on divisibility rules, unit's digit, remainders, averages. Using the concept of Alligatios, solving the problems on mixtures, Understanding the concept of surface areas and volumes, solving the 2D & 3D figures.	1,5	2
CO4	Understand the three dimensions of a cube and answer questions based on the concept of 3-D rotation. Understand the concept of Binary Logic and the techniques used in binary logic to solving the problems using method of assumptions. Understand how to organize the data based on a set of constraints.	1,5	2

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-2

Course Code: 18UC3105 **L-T-P-S: 0-0-4-0**

CO#	Course Outcome	PO/PSO	BTL
CO1	To enhance the verbal aptitude and language comprehension of the students.	8,10	2
CO2	To improve aptitude, problem solving skills and reasoning ability of the students	8,10	2
CO3	to develop skills that enable students to identify quickly the critical issues and logically derived conclusions from written facts or data.	1,5	2
CO4	To understand the Number and Letter Series, Number and Letter Analogy, Coding and decoding, Odd man out, Selections	1	1

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.

Text Books

1. Dr. Meenakshi Raman and Dr. Sangeetha Sarma: *Technical Communication*.Oxford University Press: Delhi.2016.
2. M. Ashraf Rizvi: *Effective Technical Communication.* New Delhi:McGraw Hill Education(India) Private Limited

Reference Books

3. Tom Rath: Strengths Finder2.0. New York:Gallup Press.2007.
4. C. Weaver. *Reading Process and Practice*. Portsmouth US: Heinemann Educational Bokks.1888.

CAMPUS TO CORPORATE

Course Code: 18UC3206 **L-T-P-S: 0-0-4-0**

Lexis -2: Vocabulary-Analogies–Advanced Level, Words often Confused, Word Classification, Idioms and Phrases, Sentence Completions, Paragraph Jumble. Writing Skills–Resume, Email Writing, Company Profile, Briefing and Debriefing, Press note, Catch Phrases, Caption Writing **Critical Thinking**: Engineering Ethics through Case Analysis: Ford Pinto, Chernobyl, Hyatt Residency, Bhopal Gas Tragedy, Boys of Football Team-Rescue Operation from the Than Luang Cave in Thailand **Interview Skills:** Personal Interview-Concept and Practice**,** Telephone-Etiquettes, Email-Etiquettes, Dress code and Grooming, Preparing Portfolio, Group Discussion**,** Mock Interviews, Unconventional HR questions **Simulated Testing:** Co-Cubes, E-Litmus and Amcat Practice, Infosys Placement Papers, Wipro Placement Papers, CTS and Accenture Paper Pattern

Reference Books

1.Ken Taylor. *Telephoning and Teleconferencing Skills*. Hyderabad: Orient Black Swan.2008.
2.E. Suresh Kumar, B. Sandhya.*Communication for Professional Success.* Delhi: Orient Black Swan.2013
3. Judith Verify: *Succeeding at Interview*. Mumbai: Viva Books Private Limited.2000
4. Norman L. Frigon, Sr.&Harry K.Jackson, Jr. *The Leader- Developing the Skills and Personal Qualities.* Mumbai*:* Magna Publishing Co Ltd.2000.

INDIAN HERITAGE & CULTURE

COURSE CODE: 18UC0007 **L-T-P-S: 0-0-2-0**

CO No	Course outcome's	PO	BTL
1	Familiarizing students with various aspects of Indian culture and how they contribute to the concept of Unity in Diversity	1	1
2	Understand the beginnings of Indian History and the developments during the Ancient period	1	1
3	Understand the developments in India during the Medieval Age along with how they contributed to Indian civilization	1	1
4	Understand the reasons for colonial rule over India and how independence was achieved from British rule	1	1

Syllabus:

Introduction-Concept of Culture-Culture and Civilization-General Characteristics of Indian Culture-Importance of Culture-Unity in Diversity. History and Culture through the Ages – Fundamental Unity of Harappan and Vedic Culture – Jainism and Buddhism-Mauryan Period-Post-Mauryan Period-Gupta Period-Pallavas and Cholas. Advent of Islam in India-Islam and Sufism-Islamic Art and Architecture-Bhakti Movement-Vijayanagar Period-Art and Architecture and Literature. Rise of the West and its impact on India-Social and Religious reformers in the 18th and 18th 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 & Kalikinkar Datt: Macmillan India Ltd.
6. The Wonder that was India : A.L.Bhasham.

INDIAN CONSTITUTION

COURSE CODE: 18UC0008 **L-T-P-S: 0-0-2-0**

CO No	Course outcome's	PO	BTL
1	To understand Constitutional development after Independence	12	2
2	To learn the fundamental features of the Indian Constitution	12	2

3	To get a brief idea of the powers and functions of Union and State Governments	12	2
4	To understand the basics of working of Indian Judiciary and the Election Commission	12	2

Syllabus:

Making of the Constitution: A brief analysis of National Movement. Constitutional Development with reference to Government of India Act 1809, 1818, 1835 and Indian Independence Act 1847. 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 Lok Sabha and the Rajya Sabha, 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 Courts – composition, Jurisdiction and functions, Judicial review, Judicial activism, Independence of Judiciary In India. **Election Commission:** Role and Functioning, Chief Election Commissioner and Election Commissioners

Reference Books:

1. Indian Polity' by Laxmikanth
2. Indian Administration' by Subhash Kashyap
3. 'Indian Constitution' by D.D. Basu
4. 'Indian Administration' by Avasti and Avasti
5. 'Constitutional Law of India' by Seervai H.M.
6. 'Constitution Of India' by Shukla V.N.
7. 'The Indian Constitution: Cornerstone of a Nation' by Granville Austiin
8. 'Indian Constitutional Law' by M.P. Jain

ECOLOGY AND ENVIRONMENT

Course Code: 18UC0009 **L-T-P-S: 2-0-0-0**

CO No:	CO	PO	BTL
CO 1	Understand the importance of environmental education and the conservation of natural resources.	6	1
CO 2	Understanding the importance of ecosystems and biodiversity.	12	2
CO 3	Understanding the environmental pollution.	6	1
CO 4	Understanding the solid waste management, disaster management and EIA process.	6	1

Syllabus: The Multidisciplinary nature of Environmental Studies - Natural Resources- Forest resources - Mining its impact on environment - Water resources - Mineral resources-. Energy resources - Land resource s- Soil erosion - Ecosystems - Biodiversity and its ConservationEnvironnemental Pollution - Soil waste management - Electronic waste management, biomedical waste management - Disaster management –.Environmental Legislation Environmental Impact Assessment Process.

Text Books:

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

UNIVERSAL HUMAN VALUES & PROFESSIONAL ETHICS

COURSE CODE: 18UC0010 **L-T-P-S: 1-0-2-0**

CO No:	CO	PO	BTL
CO 1	Realize and Understand the basic aspiration, harmony in the human being.	8	1
CO 2	Envisage the roadmap to fulfill the basic aspiration of human beings.	8	1
CO 3	Analyze the profession and his role in this existence.	8	1
CO 4	Understand the profession and his role in this existence.	8	1

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 Book:

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

MANAGEMENT ELECTIVES

PARADIGMS IN MANAGEMENT THOUGHT

COURSE CODE: 18MB4051 **L-T-P-S: 3-0-0-0**

Credits: 3

SYLLABUS: Management Introduction - Early management thought - Management Concept – Nature - Management as art, science, profession - Scope and functions of Management - Levels of Management - Importance of management. **Classical Approach to Management: (a) Scientific Management-** The advent of Scientific Management – Frederick W Taylor's contributions, - Contribution by Henry L Gantt - Contribution by Frank, Lillian Gilberth. **General Administrative Approach**: Henry Fayol's contributions towards general management – Max Weber's Bureaucracy Approach. **Quantitative Approach:** Important contributions – TQM – implications in today's management – Six sigma. **Behavioral Approach**: Organizational Behaviour – Contributions of Elton Mayo's – .Hawthorne studies – contributions of Mary Parker Follett – Chester Bernard. **Contemporary Approach:** Systems Theory – Contingency Theory – Chao's Theory -Peter F Drucker Contributions – C K Prahlad's Contribution – Porter's theory – Worker Management – Employee Engagement – People Capability Maturity Model.

Text Book(s):

1. Management by Stephen P Robbins, Mary Coulter, Neeharika Vohra – Pearson – 10th edition

Reference Books:

1. Management by Stoner, Freeman, Gilbert – PHI – 7th edition.
2. Management A Global & Entrepreneurial Perspective – Weihrich, Cannice, Koontz – Mc Graw Hill – 13th Edition.
3. The evolution of management thought by Daniel A Wren, Arther G Bedeian : john wiley& sons

INDIAN ECONOMY

COURSE CODE: 18MB4052 **L-T-P-S: 3-0-0-0**

Credits: 3

SYLLABUS: Economy: Meaning, types, problems and functions – Features of Indian Economy: Circular flow of economic activity: two sector, three sector and four sector models. Sectoral distribution of the economy. Nature and features of Indian Economy; Sectoral contribution of National Income-Share of Public and Private Sectors in GDP.

Agricultural Sector of India: importance and general problems; Land Reforms, Agricultural marketing problems and remedies. Industrial Sector of India: Types, Importance and general problems: Small Scale Sector: Importance and general problems.

Tertiary Sector in India- Importance – Infrastructure Development – Transport – Roadways, Railways – Banking and Insurance –Communication – Science and Technology – Software. Personal Income distribution and causes of inequality - Unemployment causes and remedial

measures; Poverty in India- Poverty Line – antipoverty programs. Human development: concept and measurement - Human Development Index.

Economic Planning in India: Role of Planning Commission - Over all Objectives and achievements of various Five Year Plans. 12th Five Year Plan; Economic Liberalisation: LPG strategy-General Agreement on Tariffs and Trade (GATT) - Objectives of GATT and Evolution of WTO – WTO and the Indian Economy, NABARD and World Bank.

Recommended Text Book(s):

1. G.Dutt and K.P.M.Sundaram: Indian Economy (2011), S.Chand&Co., New Delhi.
2. S.K.Mishra and V.K.Puri: Indian Economy, 30th ed., Himalaya Publishing House, New Delhi.
3. M.L.Jingan: Macro Economics, 6th ed., Konark Publishing House.

Reference Books:

1. P.K.Dhar, Indian Economy-Its growing dimension, Kalyani Publishers.
2. Alok Ghosh, Indian Economy, Its Nature and Problem, World Press.
3. A.N.Agarawal, Indian Economy- Problems of Development and Planning, New Age

MANAGING PERSONAL FINANCES

COURSE CODE: 18MB4053 **L-T-P-S: 3-0-0-0**

Credits: 3

SYLLABUS: Financial planning process: Introduction-Importance of Financial Planning-Process of financial planning -The planning environment-Determinants of personal income-Financial statements and plans-Concept of Time value of money - Preparing a personal balance sheet - Preparing the income and expense statement-Using personal financial statements - Ratio Analysis.

Managing Taxes: Introduction-Importance of tax planning-Basic concepts of income tax - Personal taxation -Income tax benefits on certain long term investments -Tax planning-Ethical consideration in tax planning.

Making decisions regarding houses and automobiles:- Meeting housing needs-The rental option - The home buying process - Financing the housing transaction - Housing finance institutions in India - Housing schemes in India- Automobile purchase planning.

Planning for Investments:- Types of investment vehicles-Factors considered in the choice of investments- Developing the investment strategy-Investing in Equities- Investment Process-Investing in Fixed Income Securities- Bond Market-Bond Investing Strategies-Types of Bonds-Bond Returns- Risks from Investing in Bonds

Insurance & Mutual Funds:-Insurance planning - Buying a life insurance - Life insurance products in India- Health Insurance-Need-Types and Sources of health care plans-Providers of Health care-Long term care insurance-Disability income insurance-Health Insurance in India; Mutual funds – Types of mutual fund products – Objectives of investing in Mutual funds.

Recommended Text Book(s):

1. Jack R Kapoor, “Personal Finance” Mc Graw Hill Publications, New Delhi, 2008.
2. KC Mishra and Steward Doss, “Basics of Personal Financial Planning” Cengage Learning, First Edition 2009.

Reference books:

1. Joehnk, Billingsley and Gitman "Planning Your Personal Finances" Cengage Learning India Private Limited, Delhi, 2012.
2. Mark Hirschey and John Nofsinger "Investments Analysis" and Behavior" Mc Graw Hill Publications, New Delhi, 2008.

BASICS OF MARKETING FOR ENGINEERS

COURSE CODE: 18MB4054 **L-T-P-S: 3-0-0-0**

Credits: 3

Introduction and Nature of Marketing: Evolution of Marketing Concept - Core concepts of marketing - Scope and Importance of Marketing. -Difference between Selling and Marketing - Marketing Myopia - Consumer Marketing Vs. Industrial Marketing.

Understanding Consumer Behaviour: nature, scope and importance of consumer behavior – Factors influencing Consumer Behavior - Buying decision making process - Market Segmentation, Targeting and Positioning (STP).

Marketing mix - Product definition, levels of product, product classification, difference between goods and services, Product Life Cycle, New Product Development – Technology and Product Management - Concept of Pricing – Factors influencing the pricing policy – Pricing strategies - Pricing Considerations in High-Tech Markets.

Promotion mix - Marketing Communication Tools for High-Tech Markets - Channels of distribution - Supply Chain Management in High-Tech Markets - Technology Marketing, Green Marketing, Introduction to market study.

Text Books:

1. Philip Kotler and Gary Armstrong- Principles of Marketing- 17/e, Pearson Education.
2. Jakki J Mohr, Sanjit Sengupta and Stanley Slater, Marketing of High-Technology Products and Innovations, 3/e Pearson India

Reference Books:

1. V.S. Ramaswamy and S.Namakumari – Marketing Management, 4/e, Mc Millan Publications, New Delhi.
2. RajanSaxena, Marketing Management- 3/e, TMH, New Delhi.

ORGANIZATION MANAGEMENT

COURSE CODE: 18MB4055 **L-T-P-S: 3-0-0-0**

Credits: 3

SYLLABUS: Development of Management thought – Introduction, Various theories; Functional approach, scientific management approach, human relations approach, latest management thoughts, organization theory-classical organization, neo-classical organization theory, modern organization theory.

Organization Structure--Principles of organization, organizational theories, departmentalism, authority, power, organizing, organizational effectiveness, structuring the organization, organizational change, organization charts; types of organizations—line , functional and line and staff relations, Organizational manuals.

Motivation, Morale and behavioral science—Motivation: Characteristics, importance, Kinds of motivation. Thoughts of motivational philosophy: Gouglass Mc Gregore—X and Y theory; Herzberg's theory. Human needs, Incentive as motivators, Managing dissatisfaction and

frustration. Morale, Absenteeism, Behavioral science, Group dynamics, Group behavior. Leadership—Meaning, importance, styles, theories, leaders Vs managers.

Management concept—Management, Administration, Organization, Difference and Relationship between Management, Administration and Organization, Importance of Management, Characteristics of management, Managerial Skills, Managerial Objectives, Harmonization of Objectives, Hierarchy of Objectives.

Industrial Relations, Trade Union and Collective Bargaining—Industrial relations, Industrial Psychology, Industrial disputes, Conflict management, Views about conflict, Labor Policy. Workers grievances, Suggestion system. Trade Unions. Collective Bargaining, Negotiations, Industrial Safety—working conditions, Accidents, Preventive measures, Safety training.

TEXT BOOKS

1. Stephen P. Robins, Organizational behavior, PHI / Pearson education, 11^{t} edition , 2008.
2. Koontz &Wehrich., Essentials of Management, 12th edition, Tata Mc Grawhill, 2007.

REFERENCES

1. Banga&Sarma , Industrial Engineering Management including Productionmanagement, 11th edition, 2010.
2. O.P. Khanna , Industrial engineering management, Khanna publications, 2006.

RESOURCE, SAFETY AND QUALITY MANAGEMENT

COURSE CODE: 18MB4056 **L-T-P-S: 3-0-0-0**

Credits: 3

Resource Management (Man Power, Materials & Machinery): Introduction; Resource smoothing; Resource Leveling, Establishing workers productivity; Objectives of material management;Functions of material management department; ABC classification of materials; Inventory of materials; Material procurement; Storage management;Classification of construction equipment; Earth moving equipment; Excavation equipment; Hauling equipment; Earth compaction equipment; Hoisting equipment; Concrete plant and equipment; Time and motion study; Selection of equipment – Task consideration, cost consideration; Factors affecting the selection; Factors affecting cost owning and operating the equipment; Equipment maintenance.

Safety and Quality Management: Accident prevention program; Immediate attention in case of accident; Approaches to improve safety in construction; Safety benefits to employees, employees and customers; Prevention of fire in construction industries; Fault tree analysis; Safety information system; Safety budgeting;

Importance of quality; Elements of quality; Organization for quality control; Quality assurance techniques; Documentation; Quality control circles; Total quality management; ISO 9000 – 2008.

TEXT BOOKS:

1. Construction Engineering and Management by S.Seetharaman; Umesh Publications, NaiSarakl, Delhi.
2. Fundamentals of PERT/CPM and Project Management by S.K.Bhattacharjee; Khanna Publishers, NaiSarak; Delhi.

REFERENCE BOOKS:

1. Construction Management and Planning by B.Sengupta and H.Guha; Tata Mc.Graw-Hill Publishing Co. Ltd., New Delhi.
2. Construction Planning, Equipment and Methods by Peurifoy R.L; MC Graw-Hill International Book Company.

ECONOMICS FOR ENGINEERS

COURSE CODE: 18MB4057 **L-T-P-S: 3-0-0-0**
Credits: 3

Introduction to Engineering Economics: Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Elementary economic Analysis

Unit II: Value Engineering: Make or buy decision, Value engineering – Function, aims, value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Cash Flow: Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the method

Replacement and Maintenance Analysis: Introduction-Types of maintenance –types of replacement Problem-Determination of economic life of an asset-Replacement of existing asset with a new asset. Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction.

Text Books:

1. Dr. K K Patra, DhirajBhattacharjee, Engineering Economics and Costing, S. Chand & Company Ltd, New Delhi, 2013.
2. PanneerSelvam, R., ***Engineering Economics***, Prentice Hall of India Ltd, New Delhi, 2001.

Reference Books:

1. Chan S.Park, ***Contemporary Engineering Economics***, Prentice Hall of India, 2002. Donald.G. Newman, Jerome.P.Lavelle, ***Engineering Economics and analysis***Engg. Press, Texas, 2002.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, ***Engineering Economy***, Macmillan, New York, 1884.
3. William G. Sullivan, Elin M Wicks, and James Luxhoj, Engineering Economy, 13th edition (Prentice-Hall)

BASIC SCIENCE COURSES

SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA

Course Code: 18SC1103 **L-T-P-S: 3-0-0-0**

Pre-requisite: NIL **Credits: 3**

CO No:	COURSE OUT COME	PO	BTL
1	Model the physical laws and relations mathematically as a first order differential equations, solve by analytical and numerical methods also interpret the solution.	1	1
2	Model physical laws and relations mathematically as a second/higher order differential equations, solve by analytical method and interpret the solution.	1	1
3	Obtain the Fourier series expansions of periodic functions and use the series to solve ordinary differential equations.	1	1
4	Model physical problems mathematically as a system of linear equations and solve them by analytical and numerical methods. Also, determine the nature of Quadratic form using Eigen values.	2	1

SYLLABUS:

Differential Equations: Definitions and terminology and mathematical models used in differential equations. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with first and higher-order also systems of linear first-order differential equations. Solutions of first order ordinary differential equations by Numerical methods.

Fourier series: Definitions and Fourier series for a periodic signal. Fourier series for simple functions. Fourier series of the summation of sinusoids directly from the definition by using Euler's formula. Solving particular solution to differential equation by Fourier series.

Matrix algebra: Solving linear System of equations by Gauss-elimination, L U decomposition and Jacobi, Gauss Seidal iteration methods, orthogonal, symmetric, skew-symmetric, Hermitian, Skew-Hermitian and unitary matrices, Eigen values, Eigen vectors and their properties, Cayley -Hamilton theorem (without proof) and its applications, and quadratic forms.

Text books:

1. Advanced Engineering Mathematics, Erwin Kreyszig. John Wiley & Sons, Inc. 10th Ed.
2. Advanced Engineering Mathematics, Greenberg, PHI Publishers, 2nd Edition.

Reference Books:

1. Differential Equations for Engineers, Wei-Chau Xie, Cambridge University Press, NY.
2. Higher Engineering Mathematics, BS Grewal. Publisher: Khanna, New Delhi.
3. Advanced Numerical Methods with MATLAB, SC Chapra, Tata McGraw-Hill.

MULTIVARIATE CALCULUS

Course Code: 18MT1201 **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL **Credits: 4**

CO No	Course Outcome	PO	BTL
1	Determine extreme values for functions of several variables	1	1
2	Determine area, volume moment of inertia through multiple integrals in Cartesian or polar co-ordinates.	1	2
3	Apply the concepts of vector calculus to calculate the gradient, directional derivative, arc length, areas of surfaces and volume of solids in practical problems	1	2
4	Obtain analytical and numerical solutions of Heat and wave equations	1	2
5	Verify the solution of problems through MATLAB	11	3

SYLLABUS:

Differential Calculus: Partial derivatives, Jacobian, total differentiation and their applications, chain rule, Taylor's series for function of two variables, maxima and minima of functions of two variables, Lagrange's multipliers method.

Integral Calculus: Line integrals- double and triple integrals and applications to area, volume, mass & moment of inertia. Change of order of integration, change of variables in polar, cylindrical and spherical polar coordinates.

Vector Calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of a vector point function. Line, surface and volume integrals, Green's, Gauss divergence and Stoke's theorems and their applications

Partial differential equations: Formation of partial differential equations, solutions of first order linear and nonlinear PDEs by Lagrange method, solution of second order PDEs by method of separation of variables i.e., one dimensional wave and heat equations, Laplace equation in two dimensions. Solving Laplace equation by Finite difference method.

Text books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley &Sons, Inc, Newyork . (2015)
2. Nakhle H Asmar, Partial differential equations with Fourier series and boundary value problems, Second edition Pearson Pub.

Reference Books:

1. Michael Greenberg, Advanced Engineering Mathematics. Second edition, Prentice **Hall, USA.**
2. Zafar Ahsan, Differential equations and their applications, second edition, PHI
3. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, India.

LOGIC AND REASONING

Course Code: 18SC1105 **L-T-P-S: 0-0-2-0**

Pre-requisite: NIL **Credits: 1**

CO No	Course Outcome (CO)	PO/PSO	BTL

1	Understand how to use Venn diagrams to find the conclusion of statements, solve puzzles using binary logic.	1	1
2	Understand to solve problems on clocks, calendars and problems on Non verbal reasoning.	1	1
3	Understand the available models for Venn diagrams with given data, solve problems relating to cubes and number and letter series.	1	1
4	Understand the techniques used to solve problems puzzles using analytical reasoning on coding and decoding and blood relations	1	1

SYLLABUS:

Permutation and Combinations: Fundamental Principle of Counting, Counting Methods, Definition of permutation, Linear Permutations, Rank of a word, Circular Permutations, Definition of Combinations, Problems on Combinations

Probability: Definitions of Probability, Addition and Multiplication Theorems.

Deductions: Introduction, expressing different types of statements using Venn diagrams, Definition of complimentary pairs, Finding the conclusions using Venn diagrams for two and more statements. **Logical Connectives:** Definition of simple statement, Definition of compound statement, Finding the implications for compound statements, Finding the negations for compound statements. **Binary Logic:** Definition of a truth-teller, Definition of a liar, Definition of an alternator, solving problems using method of assumptions, solving analytical puzzles using binary logic. **Cubes:** Basics of a cube, Finding the minimum number of cuts when the number of identical pieces are given, Finding the maximum number of pieces when cuts are given, Problems on painted cubes of same and different colors, Problems on cuboids, Problems on painted cuboids, Problems on Dice. **Data Sufficiency:** Different models in Data Sufficiency, Problems on Data sufficiency, Problems on data redundancy.

Data Interpretation: Problems on tabular form, Problems on Line Graphs, Problems on Bar Graphs, Problems on Pie Charts. **Analytical Reasoning puzzles:** Problems on Linear arrangement, Problems on Circular arrangement, Problems on Double line-up, Problems on Selections, Problems on Comparisons. **Number and letter series:** Difference series, Product series, Squares series, Cubes series, Alternate series, Combination series, Miscellaneous series, Place values of letters.**Number and Letter Analogies:** Definition of Analogy, Problems on number analogy, Problems on letter analogy, Problems on verbal analogy.

Odd man out: Problems on number Odd man out, Problems on letter Odd man out, Problems on verbal Odd man out.**Coding and decoding:** Coding using same set of letters, Coding using different set of letters, Coding into a number Comparison & Elimination

Text Books

1. A modern approach to Logical reasoning, R S Agarwal, S. Chand Publications.

Reference Text Books

1. Logical Reasoning, Arun Sharma, Mc Graw Hill.
2. Analytical & Logical Reasoning, Peeyush Bhardwaj, Arihant Publications.

FOUNDATIONS OF COMPUTATIONAL MATHEMATICS

Course Code: 18SC1104 **L-T-P-S: 0-0-2-0**
Pre-requisite: NIL **Credits: 1**

CO No	Course out come	PO	BTL
1	Identify the quantities of Real world problems by using the concepts of arithmetic.	**1**	**1**
2	Computing the areas of regular and irregular solids of real world problems.	**1**	**1**
3	Identifying the numbers by successive division also finding the solution of equations.	**1**	**1**
4	Estimating the roots of an equations and find the unknown values from the data by numerical methods	**1**	**1**

SYLLABUS:

Numbers: Bodmas Rule, Fractions & Decimals, Classification of numbers, Divisibility rules, factorization, Division & Successive division, Remainders in divisions involving higher powers, LCM and HCF and Number systems.

Algebra: Powers, roots and Indices, Venn diagrams, Surds, Logarithms, Quadratic Equations & Inequalities, Progressions, Simple Equations. Transposing formulae and solving simultaneous equations.

Arithmetic: Ratios, Proportion, Variation, Percentages, Profit & Loss, Simple & Compound Interest, Averages, Mixtures and Allegations, Time and Distance, Time and Work, Clocks, Calendars and Blood relations

Geometry and Mensuration: Lines & angles, triangles, quadrilaterals, polygons, circles, surface areas, volumes of 3D figures, graphs reducing non-linear laws to linear form and graphs of exponential functions.

Prescribed Text Books

1. Basic Engineering Mathematics**,** John Bird, Fourth Edition, Elsevier.

Reference Text Books

1. Quantitative Aptitude, R. S. Aggarwal, Schand Publications.
2. Quantitative Aptitude - G. L. Barrons.
3. Quantitative Aptitude - Abhijit Guha, Mc Graw Hills.

BIOLOGY FOR ENGINEERS

Course code: 18BT1001 **L-T-P-S: 2-0-0-0**
Pre-requisite: NIL **Credits: 2**

CO No:	Course Outcome	PO	BTL
1	Understand the basis of Life, Living organisms and human body systems	1,3,4,8	**2**

2	Understand the importance of Diet and Nutrition	1,3,4,8	**2**
3	Acquire the knowledge of beneficial and harmful Microorganisms and Biosensors	1,3,4,8	**2**
4	Understand the importance of Biosensors	1,3,4,8	**2**

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

PHYSICS FOR ELECTRONIC ENGINEERS

Course Code: 18PH1005 **L-T-P-S: 3-0-2-0**

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

CO No:	Course Outcome	PO	BTL
1	Understand the structure of solids and classification of solids based on their Energy Bands.	1,7	**1**
2	Understand the conducting and semiconducting properties of solids at the microscopic level.	1,7	**1**
3	Understand the dielectric properties of materials at the microscopic level and their applications.	1,7	**1**
4	Understand the magnetic interactions in materials and applications.	1,7	**1**
5	Apply the knowledge on the structure and properties of materials while executing related experiments and develop some interdisciplinary projects	7	**1**

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: 18PH1004 **L-T-P-S: 3-0-2-0**

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

CO No:	Course Outcome	PO	BTL
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.	1,7	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.	1,7	1
3	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	1,7	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	1,7	1
5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects.	7	1

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: 9781806574109.
3. Rangwala, Engineering Materials (Material Science)**,** Charotar Publishing House PVT. LTD.ISBN-10: 9380358261.

QUANTUM MECHANICS FOR ENGINEERS

Course Code: 18PH2101 **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.	1	2
2	Understand the Wave function and its Physical properties.	1	2
3	Understand the applications of Quantum Mechanics for some semiconducting components.	1	2
4	Understand some simple Quantum Systems	1	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: 18CY1001 **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: 18CY1003 **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.

Organic Electronics

Course Code: 18CY1004 **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 SCIENCE COURSES

PROBLEM SOLVING & COMPUTER PROGRAMMING

Course Code: 18SC1101 **L-T-P-S: 3-0-2-0**
Pre-requisite: NIL **Credits: 4**

CO No:	COURSE OUT COME	PO	BTL
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	1
4	Implement Linear Data Structures and compare them.	4	1

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-DimensionalArrays,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. E. Balagurusamy, **"**Programming in ANSI C" 4th ed.,Tata McGraw-Hill Education, 2008 **.**
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. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.

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.

DATA STRUCTURES

Course Code: 18SC1202 **L-T-P-S: 3-0-2-0**

Pre-requisite: 18SC1101 **Credits: 4**

CO No:	COURSE OUT COME	PO	BTL
1	Apply measures of efficiency on algorithms and Analyze different Sorting Algorithms.	1,2	1
2	Analyse and compare stack ADT and queue ADT implementations using linked list and applications.	1,4	1
3	Analyse the linked implementation of Binary, Balanced Trees and different Hashing techniques.	2,4	2
4	Analyse different representations, traversals, applications of Graphs and Heap organization.	1,2	1

Syllabus: Algorithm Analysis: Mathematical Background, Model, Analyze, 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 datastructures in C" , Second Edition-2007.

3. R. F. Gilberg, B. A. Forouzan, “Data Structures”, Second Edition, Thomson India Ed ition, 2005
4. Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, “Data Structures & Program Design in C”, Fourth Edition-2007.

ENGINEERING GRAPHICS AND DESIGN FOR ELECTRONICS & COMPUTER ENGINEERS

Course Code: 18EC1002 **L-T-P-S: 0-0-4-0**

Pre-requisite: NIL **Credits: 2**

CO No:	COURSE OUT COME	PO	BTL
1	Describe some important design considerations in choosing a graphics for a specific application.	1,3,7	2
2	Acquire knowledge on orthographic projection	1,3	2
3	Examine projections of planes and solids	1,7	2
4	Explain the role of curves and sections	1,7	2
5	Analyze & generate PCB layout skills	1,4	2

Introduction to Engineering Drawing : Principles of Engineering Graphics and their significance – Drawing Instruments and their Use- Conventions in Drawing – Lettering – Geometric Constructions – Scales: Plain and Vernier scales. **Orthographic Projection in First Angle Projection:** Principles of Orthographic Projections- conventions- First and Third Angle, Projections of Points and Lines inclined to both planes, True lengths, traces. **Projections of Planes & Solids:** Projections of regular planes inclined to both planes . Projections of Regular solids inclined to one plane. **Sections and Sectional Views**:-Right Regular Solids - Prism, Cylinder, Pyramid, Cone. **Engineering Curves used in Engineering Practice & their Constructions: Conic Sections:** Ellipse, Parabola, Hyperbola and Rectangular Hyperbola – oblong, concentric method **Special Curves:** Cycloid, Epicycloid, Hypocycloid and Involute **Developments of solids:** Development of surfaces of right regular solids – Prisms, Cylinder, Pyramid cone and their parts **Isometric Projections:** Principles of Isometric Projection- Isometric Scale- Isometric view conventions- Isometric View of Lines, Plane Figures, simple problems **Transformation of Projections:** Conversion of Isometric Views to Orthographic Views – Conventions **Introduction of Computer Graphics covering & Customisation & CAD Drawing** Demonstrating knowledge of the theory of CAD software, Drawing Area, Dialog boxes and windows, Shortcut menus, Command Line, Status Bar, Different methods of zoom, erase objects. scale settings, applying dimensions to objects and annotate; use of Layers, Create, edit and use customized layers. **Electrical and Electronics drawings** Difference between electronic drawing and other practiced engineering drawing, types of electronics drawing used in the industry , standardized schematic symbols for electronic devices, identify different types of circuit board drawings. PCB structure and its

components , PCB Terminology, PCB layers and its shapes , House wiring diagrams, Electric line diagrams.

Text Books:

1. Engineering Drawing, N.D.Bhat/ Charotar
2. Engineering Drawing , N.S.Parthasarathy, VelaMurali
3. Machine drawing- N.D.Bhatt., published by R.C. Patel Charotar Book Stall Tulshi Sadan, Station Road, Annad, India
4. Dash.S.S, Subramani.C, Vijayakumar.K, "Basic Electrical Engineering", First edition,Vijay Nicole Imprints Pvt.Ltd,2013
5. Printed Circuit Boards, Design, Fabrication, Assembly and testing , Dr.R.S.Khandpur
6. Printed Circuit Board Designer's , Christopher T. Robertson
7. Textbook of Engineering Drawing, K. Venkata Reddy,(Building Drawing)
8. Thermo chemical Conversion of Biomass to Liquid Fuels and Chemicals, Mark Crocker
9. Advances in Biodiesel Production: Processes and Technologies, R Luque, J A Melero

REFERENCE BOOKS:

1. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
4. (Corresponding set of) CAD Software Theory and User Manuals
5. Machine Drawing by / Bhattacharyya / Oxford
6. Machine Drawing with Auto CAD / Goutham Pohit, Goutam Ghosh / Pearson
7. Electrical and Electronics Drawing, C.J. Baer
8. Printed Circuit Boards: Design and Technology , By Bosshart
9. Basic Biotechnology, edited by Colin Ratledge, Bjorn Kristianse

WORKSHOP PRACTICE FOR ELECTICAL AND ELECTRONICS ENGINEERS

Course Code: 18EE1003 **L-T-P-S: 0-0-4-0**

CO No:	COURSE OUT COME	PO	BTL
1	Prepare wooden Lap T, Plus joints. Prepare square and L fits. Fabricate parts made of sheet metal. Demonstrate the ability to execute stair-case lighting and godown lighting house wiring connections	12	3
2	Use arc welding equipment and tools to prepare butt joint for joining mild steel metal flats in a safe manner. Demonstrate the ability to melt and pour molten material into dies. Perform facing and plain turning on Lathe to prepare cylindrical jobs. Drill holes on Mild steel metal flats using drilling machine.	12	3
3	Identify hardware components in a computer system, Assemble and disassemble a computer system, Install operating system and software	12	3
4	Identify electronics components& soldering practice, connect identified computers in a network,	12	3

Common Experiments for ALL Branches:

CARPENTRY - Hands on practice on wood working operation using hand tools to prepare Lap T joint and plus joint.

FITTING - Hands on practice on preparing square fit and L fits.

TIN SMITHY - Hands on practice on sheet metal working for preparing cylindrical pipe and rectangular tray / Pipe T joint.

HOUSE WIRING - Hands on practice on electrical house stair-case and godown connections

WELDING - Hands on practice joining of metal plates using arc welding equipment

CASTING – Hands on practice on Gravity die casting for preparation of wax pipe flange / dumb bell.

MACHINE SHOP – Hands on practice on Lathe, Drilling machine tools

SPECIFIC TO ECE/EEE/ECM ENGINEERING BRANCH:

1. Identification of components in a computer system & network
2. Assembling and disassembling of a computer system
3. Installation of operating system and software
4. Networking of computers
5. Soldering practice
6. Identification of electronics components

TEXT BOOKS:

1. P.Kannaiah and K. L. Narayana, Engineering Practices Laboratory, 2009, SciTech Publications, Chennai

REFERENCE BOOKS:

1. KLEF workshop lab manual

2. K. Venkata Reddy, “Workshop Practice Manual”, Sixth edition, 2011 print, BS Publications, Hyderabad.

3. B S Nagendra Parashar and R K Mittal, “Elements of Manufacturing Process”, 2010 print, Prentice Hall of India, New Delhi

OBJECT ORIENTED PROGRAMMING

Course code: 18SC2009 **L-T-P-S: 2-0-2-0**

Pre-requisite: NIL Credits: 3

CO No:	COURSE OUT COME	PO	BTL
1	The student will be able to understand basic Concepts of OOP, fundamentals of java and apply the concepts of classes and objects through Java Language.	1,2	2
2	The student will be able to apply constructors, Overloading, parameter passing, in Java programming.	1,2	2
3	The student will be able to apply access control, Inheritance, Packages.	1,2	2
4	The student will be able to apply , Interfaces, Exception Handling	1,2	2
5	Students will be able to apply object oriented programming concepts to write programs.	1,2	2

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, The Object class. **Packages and Interfaces:** Packages, Classpath, Importing packages, differences between classes and interfaces, Implementing & Applying interface. **Exception Handling:** Exception Handling fundamentals.

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.

Digital System Design

Course code: 18EC1101 **L-T-P-S: 3-0-2-0**

Pre-requisite: NIL **Credits: 4**

CO No:	COURSE OUT COME	PO	BTL

1	Describe the concepts of number systems with codes and logic gates usage in digital circuit design and identify the logical expressions in different forms and their minimization techniques for logical circuit optimization	**1,2**	**2**
2	Employ Combinational logic circuits with minimization techniques and logical verification through hardware description language	**1,2**	**2**
3	Substantiation of Sequential logic circuits and logical verification through hardware description language	**1,2**	**2**
4	Implementation of digital circuits using PAL, PLA, FPGA and CPLD	**1,2**	**2**
5	Analyse the digital IC logic for combinational and sequential circuits implementation	**1,2**	**2**

Logic Simplification and Combinational Logic Design: Number Systems, Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Karnaugh maps, Binary codes, Code Conversion, Integrated Circuit Logic Gates. Combinational Logic Functions: Adder and Subtractor, Decoders, Encoders, Multiplexers, Demultiplexers, Magnitude Comparators, Parity Generators and Checkers, BCD to seven segment decoder, Verilog HDL design for Combinational Logic Functions. Sequential Logic Functions: NAND/NOR Latches Gated Latches, Edge- Triggered Flip-flops. Registers and Counters: Shift register, Universal Shift Register, Design of Synchronous and Asynchronous Counters, Modulus counters. Mealy and Moore machines, State diagrams and Tables, FSM, Introduction to ASM charts. Verilog HDL design for Sequential Logic Functions. Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Logic implementation using Programmable Devices. Complex Programmable Logic Devices, Field Programmable Gate Arrays, Applications of CPLDs and FPGAs.

Text Books:

1. Stephen Brown and Zvonko Vrane "Fundamentals of Digital Logic with Verilog Design" Second Edition, McGraw-Hill.
2. M. Morris Mano, "Digital Logic and Computer Design", Pearson

Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
2. J. Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing.
3. Digital Fundamentals by A Anand Kumar, PHI

Electronic Workshop-II
(Electronic System Design Workshop)

Course code: 18EC3110 **L-T-P-S: 1-0-2-2**

Pre-requisite: NIL **Credits: 2.5**

CO No:	COURSE OUT COME	PO	BTL

1	Capable to understand the electronic system design process, analyze the heat management system and understand the soldering techniques	**1,5**	**2**
2	Able to understand PCB fabrication process, PCB artwork and various protection methods for electronic systems.	**1,3,5,7**	**2**
3	Able to understand Raspberry Pi microcontroller and its applications	**1,3,5,7**	**2**
4	Able to understand product making steps, the noise reduction designs in components & circuits, high frequency designs and CAD packages	**1,5**	**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.	**11**	**4**

Syllabus :

CO1: Introduction: 2Hrs (a) Design Process and Its Fundamentals; Product Life Cycle; Technical Drawings, Circuit Diagrams; Protection Requirements; Electronic Systems and Classifications: Examples and case studies; (b) Heat Management and Cooling by using Heat Sinks, Soldering Techniques. CO2: Introduction to PCB Fabrication and design: 3Hrs (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. CO3: Introduction to Raspberry Pi: 3Hrs (a) Introduction to Raspberry Pi microcontroller board (b) Developing applications using Raspberry Pi microcontroller board CO4: Electronic System designs: 4Hrs (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 8. Electronic system design workshop II Lab Manual

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

Electronic Workshop-III
(IOT Applications)

Course code: 18EC2214 **L-T-P-S: 1-0-0-4**

Pre-requisite: 19SC1101 **Credits: 2**

CO No:	COURSE OUT COME	PO	BTL
1	IoT Applications & Sensors: Analog & Digital sensors, MPU 6050, MCP2515(CAN), DS3231(RTC), Applications	5	2
2	nterfacing to IoT : Micro controllers boards, ESP8266, Peripherals (Motors, Camera, Speaker, Displays), Controlling through Mobile & Web	3	2
3	IoT Data Communication: Wi-Fi Protocols, Bluetooth, BLE, WSN, Zigbee, RFID, NFC, Client Server, Cloud.	10	2
4	Protocols & Case Studies : Issues & Challenges : Security, Privacy, Scalability, Store and Analytics Case Studies: Health, Smart cities, Village/ Agriculture	7	2
5	01: BASIC LED BLINKING,02: GAS DETECTING SENSOR USING NODEMCU,03: PRESSURE SENSOR,04: SERVO MOTOR WITH ESP32,5.SERVO MOTOR CONTROL WITH BLUETOOTH,06: GREETINGS MESSAGE THROUGH WEBPAGE WITH ESP AS SERVER,07 : SERVO MOTOR CONTROL WITH WEBPAGE,08: TEMPERATURE AND HUMIDITY MONITORING IN CLOUD PLATFORM,WIFI WEATHER STATION TOOL AND ANALYSIS,10: TEMPERATURE AND HUMIDITY MONITORING WITH RASPBERRY Pi AND SERVO MOTOR,11: DIRECTION CONTROL OF A 3D	11	3

Syllabus :

IoT Applications & Sensors: Analog & Digital sensors, MPU 6050, MCP2515(CAN), DS3231(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:

internet of Things: A Hands-On Approach by Arsheep Bahga (Author), Vijay Madisetti (Author)

Web Links :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

IOT Workshop-I
(HTML, XML, WEB DESIGN)

Course code: 18EC2115 **L-T-P-S: 1-0-2-0**

Pre-requisite: NIL **Credits: 2**

CO No:	COURSE OUT COME	PO	BTL
1	Experiment with HTML/XML and Word press	2,3	3
2	Construct Arduino Interfacing and Mobile Apps (Native apps for Android Phone)	3,4	3
3	Experiment with interfacing the Raspberry Pi board with Web-App, and develop similar applications for Mobile App	3	3
4	Develop Project using Raspberry pi based controlled with Web Apps or Mobile Apps	6	3

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 Apps Development 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 the World” by Brian Evans - Technology in Action 3. “Getting Started with Raspberry pi” by Matt Richardson and Shawn Wallace – O’Reilly 4. “THE ARDUINO PROJECTS BOOK” by Scot Fitzgerald and Michael Shiloh.

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

Electrical Circuit Theory

Course Code: 18EE2105 **L-T-P-S: 3-1-0-0**

Pre-requisite: NIL Credits: 4

CO No:	COURSE OUT COME	PO	BTL
1	Understand the circuit elements and AC fundamentals for electrical networks	1,5	1
2	Apply Network theorems to Electrical networks (AC & DC)	1,5	2
3	Analyse the Two port networks, Resonance & Transients	1,5	2
4	Understand the Magnetic circuits and fundamental laws of electromagnetic induction	1,5	1

Network analysis: Basic Circuit elements, series and parallel circuits, Kirchhoff's laws, Mesh and Nodal analysis - Matrix approach of network containing voltage and current sources, and reactances, source transformation and duality. Network theorems - Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer. Star/delta transformation, source transformation. **AC Circuits-** RMS and average values and form factor of different periodic wave forms (Sinusoidal, rectangular, triangle and saw-tooth), steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation, Phase and Phase difference, concept of power factor. D.C. Machines: Constructional features and principle of operation of DC Generator, EMF Equation (No derivation), Types of Excitation systems, Torque development in Motors, Torque Equation (No derivation), Applications of DC Generators and Motors. Transformers: Principle and operation of transformers, EMF equation (No derivation) Induction Motor: Principle operation and construction of three phase induction motor, single phase induction motor and applications.

Text books:

1. S.K. Bhattacharya, "Basic Electrical and Electronics Engineering", 2nd edition, pearson, 2011.
2. Edward Hughes, "Electrical & Electronics Technology", 12th edition, Pearson, 2016

Reference books:

1. Ashfaq Husain, "Electric Machines", 2nd Edition, Dhanpat Rai& Co, 2014.
2. Jacob Millman, Christor. C W. H. Hayt, J.E. Kimmerly, "Engineering circuit analysis", 8th Edition, Tata Mc-Graw Hill, 2014.

3. Jagan and C. LAkshmi Narayana, "Network Theory", B. S. Publications.

PROFESSIONAL CORE COURSES

Computer Organization and Architecture

Course code: **18EC1202** 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 /noc18_cs04/

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

(DEEMED TO BE UNIVERSITY)

18EC2103 – Analog Electronic Circuit Design

Course code: **18EC2103** 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

(DEEMED TO BE UNIVERSITY)

Communication Signals & System Design

Course code: **18EC2104** 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**	**3**
CO2	Ability to apply the Laplace and the Fourier Transforms for the analysis of some simple Analog Signals and Systems	**1,3**	**3**
CO3	Understand the few differences in moving from the Analog to the Discrete-Time (Signals and Systems)	**1,2,8**	**3**
CO4	Apply the concepts studied so far, for the design and analysis of various applications under time-domain and frequency-domain	**12**	**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.

Embedded Controllers

Course code: **18EC2205** 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.

18EC2206 – Analog and Digital Communication

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

Pre-requisites : NIL Contact Hours : 6

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyse the linear and non linear modulation concepts	**1**	**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.

18EC2207 – DIGITAL SIGNAL PROCESSING

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

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the Analysis of FFT & Wavelets	**1,2**	**2**
CO2	Explore and Design the Digital filters: Digital FIR	**2**	**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, 1898.

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

18EC3109 – DATA NETWORKS AND 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

18EC2207-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

18EC2213-Statistics, AI, ANN-Basic course

L-T-P-S : 3-0-0-2 Credits : 3.5

Pre-requisites : NIL Contact Hours : 5

Mapping of Course Outcomes to Program outcomes:

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

Syllabus

Random Processes and Random Variables

Probability - Coin experiment, Ball experiment, Card experiment, Dice Experiment, Sequence of Coin tossing, Combination, Permutation, Probability Density function, expectations, mean, variance, Random Processes and random variables.

Stochastic Processes

Coin tossing, 2 Coin tossing, 3 Coin tossing, Biased coin tossing, Baye's theorem. Hidden Markov Model, Trellis Algorithm, Viterbi Algorithm. Introduction to Artificial Neural Networks. Cumulative Frequency -less than type-Ogive, Cumulative Frequency- more than type -Ogive.

Introduction to Artificial Intelligence

Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of Symbolic AI, Agents. **State Space Search**: Depth First Search, Breadth First Search, DFID

Heuristic Search: Best First Search, Hill Climbing, Python Programming implementation with Artificial Intelligence.

Basics of ANN, FFN, FBNN:

Overview of Artificial Neural Networks, Different Learning Methods and Architectures, Activation functions and its classification, Perceptron, Multi-Layer Perceptron, Hinton's Model, Feedforward Neural networks, Feed-Back Neural-networks**.** Introduction to CNN, RNN and DNN.

Text Books

[1]. Communication Systems by Simon Haykin

[2]. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.

Reference Books

[3]. R.O.Duda, P .E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.

[4]. Artificial Neural Networks by Prof. B. Yegnanarayana.

[5]. Simon Haykin, Neural networks and learning machines, Pearson Education, 2016

[6]. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003

Web References

1 https://nptel.ac.in/courses/106106126/

2 https://nptel.ac.in/courses/106105077/

3 https://nptel.ac.in/courses/111102014/

18EC2222-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

Flexi Core Courses

18EC2208FC – VLSI Design

Course code: **18EC2208FC** 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	**1,2,5**	**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

18EC3016 – Wireless Communications

Course code: **18EC4111** 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, 6**	**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, 1895.

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: **18EC3016** 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.

18EC3017 – Biomedical Electronics & IOT for Healthcare

Course code: **18EC3017** 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	**3,5**	**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, 2018.

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/106105185/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: **18EC3018** 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, 18th 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

18EC3019 – System Engineering, Operation Research & Designing

Course code: **18EC3019** 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, 1897

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

18EC3020 – Electrical Technologies & Solar Power Systems

Course code: **18EC3020** 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**	**3**

Syllabus:

Basics of Electrical Technologies: Elementary concepts of electric circuits, Kirchhoff's laws, constant voltage and current sources, Electromagnetic induction, DC Machine, DC Generators, DC Motors, Three phase systems, star and delta connection. Transformers and bus bars.

Power Generation and Distribution: Elements of the power grid and measurement technologies: generation, transmission, distribution, and end-user; Basic concepts of power, load models, load flow analysis and losses. Distribution system monitoring and control: SCADA, Concept of modern distribution systems.

Electrical Grids and Smart Grids: Evolution of Electric Grid - Definitions, Architecture, Functions and control layer and elements of Smart Grid. Energy management system (EMS), Wide area monitoring system (WAMS) and phasor measurement units (PMU); Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering.

Solar Photovoltaic systems: Photovoltaic Cells: Operation, performance testing of cells and efficiency - PV modules, panels, string, arrays, sub array and blocking diodes. Solar Photovoltaic Systems: Configuration, Types of system stand alone and grid connected system. Solar PV system design: design consideration, process and design aid expert with AI and ML

Text Books

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

Reference Books

1. Mehta V K and Mehta Rohit, Basic Electrical Engineering, S Chand & Company, 2006
2. Modern Power system Analysis: D P Kothari and I J Nagrath, Tata McGraw Hill

3. James Momoh, "Smart Grid Fundamentals of Design and Analysis," Wiley, 2012
4. Kaushika, N.D, Solar Photovoltaics Technology, System Design, Reliability and Viability, Springer, 2018
5. Janaka Ekanayake Smart grid Technology and application Wiley

18EC3021 – Advance Course in Soft-Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)

Course code: **18EC3022** 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,1895.

[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: **18EC3051** 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: **18EC3052** 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, 1898: Crystalline Silicon Solar Cells, 1898
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/

(DEEMED TO BE UNIVERSITY)

Electronic Systems for Renewable Energy & Smart Grid

Course code: **18EC3053** 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: **18EC3054** 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, 2018.

2 P P Anil Kumar, Introduction to Smart Cities, Pearson India; First edition, 2018.

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: **18EC3055** 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

VLSI & Micro-Electronics

Low Power VLSI

Course code: **18EC3061** 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.

3 Yeo, “CMOS/BiCMOS ULSI Low Voltage Low Power” Pearson Education.

Algorithms for VLSI Design Automation

Course code: **18EC3062** 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	**1,3,6**	**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 1899.

Reference Books

1 Hill & Peterson, “Computer Aided Logical Design with Emphasis on VLSI” Wiley,1893.

2 Wayne Wolf, “Modern VLSI Design: Systems on silicon” Pearson Education Asia, 2nd Edition.

ASIC and FPGA Chip Design

Course code: **18EC3063** 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.	**3,11**	**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.	**3,11**	**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: **18EC3064** 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: **18EC3065** 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: **18EC3066** 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, 1899.

2 Gray& Mayer, “Analysis & Design of Analog Integrated Circuits”, 4th edition, Wiley, (2001).

Automation & Robotics

Control Systems & Introduction to Robotics

Course code: **18EC3071** 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 order and Second order Systems, Steady state error and Error constants. Introduction to *PID* and *PID Controllers Stability analysis:* Concept of stability and conditions for stability, Routh – Hurwitz criterion (optional), dominant poles of *transfer function. Root Locus Technique:* Root Locus concept, basic properties, magnitude and angle conditions, effects of adding poles and zeros to G(s) H(s). *Frequency response*: Specifications, correlation, Bode-plot, phase margin, gain margin.

***Introduction of Robotics**:*

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

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

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

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

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

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

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

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

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

Text Books

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

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

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

4

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

6 Publication, New Delhi (2011).

Reference Books

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

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

3 K. Fu, R. Gonzalez, and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw - Hill, 1887.

Autonomous Vehicles & Automotive Electronics

Course code: **18EC3072** 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, 1898

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/

(DEEMED TO BE UNIVERSITY)

18EC4073 – Advanced Robotics

Course code: **18EC3073** 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: 978-3-318-77042-0,978-3318770406

[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: **18EC3074** 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 2018)

4 Bharath Hariharan's - Computer Vision class at Cornell (Spring 2018)

5 Pascal Fua's - Introduction to Computer Vision class at EPFL (Spring 2018)

6 Ioannis Gkioulekas's - Computer Vision class at CMU (Spring 2018)

7 Ioannis Gkioulekas's - Computational Photography class at CMU (Fall 2018)

8 Bill Freeman, Antonio Torralba, and Phillip Isola's 6.818/6.869- 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
18 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: **18EC3075** 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, 1894.

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: **18EC3076** 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: **18EC3081** 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 . 1887.

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: **18EC3082** 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**
CO5	Applications to real world problems	**3, 5**	**3**

Syllabus:

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

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

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

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

Text Books

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

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

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

Web References

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

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

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

18EC3083 – 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: **18EC3084** 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, 1896.

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., 1895

6 Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1885.

7 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi, 110 001,1889.

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

(DEEMED TO BE UNIVERSITY)

Adaptive Signal Processing

Course code: **18EC3085** 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, 1898.

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

Detection and Estimation of Signals

Course code: **18EC3086** 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.	**2,4**	**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, 1893.

3 Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1875.

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., 1895.

3 Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing, with Applications, Prentice Hall of India, New Delhi, 110 001,1889.

4 Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

18EC3087 – 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

18EC3091 – Information Theory & Coding

Course code: **18EC3091** 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: **18EC3092** 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: **18EC3093** 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: **18EC3094** 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: **18EC3095** 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, 2018, date of current version June 11, 2018.

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: **18EC4051** 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 1882),

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: **18EC4052** 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: **18EC4053** 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, 1st Eidtion.

2 5G Mobile Communications, Xiang, Kan Zheng, Xuemin (Sherman) Shen, Springer 2017.

Reference Text books

1 5G Mobile and Wireless Communications Technology, AfifOsseiran, Jose F. Monserrat and Patrick Marsch, - Cambridge University Press, 2016.

2 Wireless security Handbook, Aaron E. Earle, Tailor and Francis Publication

3 QoS in Wireless Data Networks, https://www.cse.wustl.edu/~jain/cse574-06/ftp/wireless_qos.pdf

Web References

1 Fundamentals of 5G mobile networks, Jonathan rodriguez, - John Wiley & Sons, Ltd, 2015

(DEEMED TO BE UNIVERSITY)

Cloud-Computing & Network Security

Course code: **18EC4054** 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,© 1899 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: **18EC4055** 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

18EC3111 – Microwave Engineering

Course code: **18EC4061** 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, 1899.
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

(DEEMED TO BE UNIVERSITY)

Antenna Design & Wave Propagation

Course code: **18EC4062** 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

Radar Engineering & Navigational Aids

Course code: **18EC4063** 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: **18EC4064** 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.

18EC4115 – Electronic Warfare, EMI & EMC

Course code: **18EC4065** 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: **18EC4071** 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, 1897. 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: **18EC4072** 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	**1,3**	**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/noc18_cs33/preview

Pattern Recognition

Course code: **18EC4073** 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	**1,3**	**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: **18EC4074** 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	**1,3**	**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: **18EC4075** 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**	**2**
CO2	Understanding of the feature extraction, pattern analysis visual geometric modelling.	**1,2**	**2**
CO3	Vehicle Tracking and Recognition, Human activity recognition	**1,2**	**3**
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

Biomedical Instrumentation

Automated Vehicles & Avionics

Course code: **18EC4081** 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, 1899
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, 1864.
4 Myron Kyton, Walfred Fried, Avionics Navigation systems, 2nd edition, John Willy & Sons, 1897.
5 Albert D Helfrick, Modern Aviation Electronics: 2nd Ed., PHI, 1894.
6 John S. Duncan, “Pilots handbook of Aeronautical Knowledge”, federal Aviation administration.
7 Jack Erjavec, “A systems Approach to Automotive Technology”, Cengage learning India Pvt. Ltd.
8 William H Crouse, “Automotive Mechanics”, 10th edition, Mc Graw Hill.
9 Dr. Kripal Singh, “Automobile Engineering”, Vol.1&2, Standard Publishers

Web references

1 https://www.autonomousvehicletech.com/events/category/66
2 https://www.dspace.com/en/ltd/home/medien/videos/webinarrecords/webinarrec_sensorsim.cfm
3 https://www.mcca.com/wp-content/uploads/2018/04/Autonomous-Vehicles.pdf
4 https://www.youtube.com/watch?v=1lUkyCYdAEY
5 https://www.youtube.com/watch?v=tiwVMrTLUWg
6 https://www.youtube.com/watch?v=OlLFK8oSNEM

Calibrations and Designing Advanced Instruments

Course code: **18EC4082** 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

(DEEMED TO BE UNIVERSITY)

Biological & Cyber-Physical Systems

Course code: **18EC4083** 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

Electronic Instruments & Biomedical Applications

Course code: **18EC4084** 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 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.]	**2,4**	**2**

Syllabus:

Fundamentals of Electronic Instrumentation: Fundamentals of Electronic Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis. Calibration - Primary and secondary standards. 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.