VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Third Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.) Degree
in
Electronics and Telecommunication Engineering

Implemented from the batch admitted in Academic Year 2023-2024

[NEP 2020 Based Syllabus]

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(109)

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Institute Vision

- To establish global leadership in the field of Technology and develop competent human resources for providing service to society

Institute Mission:

- To provide students with comprehensive knowledge of principles of engineering with a multi-disciplinary approach that is challenging
- To create an intellectually stimulating environment for research, scholarship, creativity, innovation, and professional activity.
- To foster relationship with other leading institutes of learning and research, alumni, and industries in order to contribute to National and International development.

Department Vision

- To establish global leadership in the field of Electrical, Electronics & Communication Engineering and to develop competent human resources for providing service to society.

Department Mission

- To provide student with comprehensive knowledge for taking up challenges in the field of Electrical Engineering with a multi-disciplinary approach.
- To create an intellectually stimulating environment for research, industry interaction, creativity, innovation and professional activity.
- To foster relationship with renowned institutes of learning and research, alumni and industries in order to contribute to National and International development.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

Electronics and Telecommunication Engineering Graduates will have ability to

1. Deliver fundamental as well advanced knowledge with research initiatives in the field of Electronics and Communication Engineering with emphasis on state of the art technology.
2. Design solutions for electronic systems for real-world applications which are technically feasible and economically viable leading to societal benefits.
3. Demonstrate leadership qualities and professional attitudes to deal with challenges.

PROGRAMME OUTCOMES

Engineering Graduate will be able to:

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

Electronics and Telecommunication Engineering Graduate will be able to:

1. Design, develop and test electronic and telecommunication systems in the areas related to analog and digital communication, signal processing and VLSI design.
2. Analyze, design and implement systems to strive balance between increasing complexity, robustness and performance of systems.
3. Design software and hardware systems, components or process to meet desired needs within realistic constraints.

Credit Framework for Multidisciplinary UG Programme in Electronics & Telecommunication Engineering (Level 5.5) - Semester - V

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %			Ownership
									TA	MST	ESE	
1	PCC	R5ET3001T	Electromagnetic Fields and Waves	3	0	0	3	3	20	30	50	EXTC
2	PCC	R5ET3002T	Control Systems	3	0	0	3	3	20	30	50	EXTC
3	PCC	R5ET3003T	Digital Signal Processing	3	0	0	3	3	20	30	50	EXTC
4	PCC	R5ET3004T	Computer Communication Networks	3	0	0	3	3	20	30	50	EXTC
5	PCC	R5ET3005T	Telecom Network Management	2	0	0	2	2	20	30	50	EXTC
6	PEC	R5XX31XXT	Program Elective –I	3	0	0	3	3	20	30	50	EXTC
7	MDM	R5XX32XXT	Multi-disciplinary Minor-III	3	0	0	3	3	20	30	50	Respective Department
8	PCC	R5ET3003L	Digital Signal Processing Lab	0	0	2	2	1	ISCE:60		40	EXTC
9	PCC	R5ET3004L	Computer Communication Networks Lab	0	0	2	2	1	ISCE:60		40	EXTC
10	PCC	R5ET3005L	Telecom Network Management Lab	0	0	2	2	1	ISCE: 60		40	EXTC
11	PEC	R5XX31XXL	Program Electrive-I Lab	0	0	2	2	1	ISCE:60		40	EXTC
			Total	20	0	8	28	24				

Semester - VI

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %			Ownership
									TA	MST	ESE	
1	PCC	R5ET3006T	Microwave Communication	2	0	0	2	2	20	30	50	EXTC
2	PCC	R5ET3007T	Embedded Systems	2	0	0	2	2	20	30	50	EXTC
3	PCC	R5ET3008T	Wireless Communication	2	0	0	2	2	20	30	50	EXTC
4	OE	R5XX33XXT	Open Elective-I	3	1	0	4	4	20	30	50	Respective Departments
5	PEC	R5ET31XXT	Program Elective –II	3	0	0	3	3	20	30	50	Electronics
6	MDM	R5XX32XXT	Multi-disciplinary Minor-IV	3	0	0	3	3	20	30	50	Respective Departments
7	HSSM	R5EL3401T	Financial Planning / Taxation / Management	2	0	0	2	2	20	30	50	EXTC
8	VEC	R5ET3401T	Communication in Service to Society	1	0	2	3	2	ISCE:60		40	EXTC
9	PCC	R5ET3006L	Microwave communication Lab	0	0	2	2	1	ISCE:60		40	EXTC
10	PCC	R5ET3007L	Embedded Systems Lab	0	0	2	2	1	ISCE:60		40	EXTC
11	PCC	R5ET3008L	Wireless Communication Lab	0	0	2	2	1	ISCE:60		40	EXTC
12	PEC	R5ET31XXL	Program Elective –II Lab	0	0	2	2	1	ISCE:60		40	EXTC
			Total	18	1	10	29	24				

MDM Courses offered by Electronics & Telecommunication Engineering

Sr. No.	Course code	Name of MDM	Name of the MDM Course	Semester
1	R5ET3201T	Cyber Security	Network Security	V
2	R5ET3202T	Electronics & Communication	Principles of Communication System	V
3	R5ET3203T	Cyber Security	IOT and Cloud Security	VI
4	R5ET3204T	Electronics & Communication	Data communication	VI

Abbreviations: **L** Lecture, **T** Tutorial, **P** Practical, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

Program Elective Offered by Electronics & Telecommunication Engineering

		Course code	Name of the Course	Semester
Elective-I	1	R5EL3101T	Digital VLSI Design	V
		R5EL3101L	Digital VLSI Design Lab	V
	2	R5EL3102T	Data Compression and Encryption	V
		R5EL3102L	Data Compression and Encryption Lab	V
	3	R5EL3103T	Image Processing	V
		R5EL3103L	Image Processing Lab	V
	4	R5EL3104T	Introduction to Artificial Intelligence	V
		R5EL3104L	Introduction to Artificial Intelligence Lab	V
	5	R5ET3101T	Microprocessor Systems	V
		R5ET3101L	Microprocessor Systems Lab	V
	6	R5ET3102T	Wireless Sensor Networks	V
		R5ET3102L	Wireless Sensor Networks Lab	V
Elective-II	1	R5EL3106T	Introduction to microfabrication	VI
		R5EL3106L	Introduction to microfabrication Lab	VI
	2	R5EL3107T	Error-correcting codes	VI
		R5EL3107L	Error-correcting codes lab	VI
	3	R5EL3108T	Advanced Digital Signal Processing	VI
		R5EL3108L	Advanced Digital Signal Processing Lab	VI
	4	R5EL3109T	Data Science	VI
		R5EL3109L	Data Science Lab	VI
	5	R5ET3103T	Basics of IoT	VI
		R5ET3103L	Basics of IoT Lab	VI
	6	R5ET3104T	Next Generation Networks	VI
		R5ET3104L	Next Generation Networks Lab	VI

List of Exit Courses after completion of Semester V and VI

1. Exit option is available for students who have earned the total 132 credits at the End of Second Semester.
2. Students who want to avail the exit option after third year have to earn additional 6-8 credits from the list of courses shown below.
3. These courses students have to complete within summer vacation after Third Year.
4. After fulfillment as mentioned in 1 to 3 above, Students can earn B. Voc. or B. Sc. (Tech.) and the same will be issued by the Institute.

List of Exit Courses after completion of Semester V and VI: E&TC Engineering											
Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	EC	R5ET3901T	Basics of Mobile Communication	2	0	0	2	2	20	30	50
2	EC	R5ET3902T	Basics of Antennas	2	0	0	2	2	20	30	50
3	EC	R5ET3901L	Basics of Mobile Communication Lab	0	0	2	2	1	ISCE:60		40
4	EC	R5ET3902L	Basics of Antennas Lab	0	0	2	2	1	ISCE:60		40
5	EC	R5ET3901I	Internship (6-8 weeks)					6	ISCE :60		40
6	EC	R5ET3901P	Mini-Project	0	0	12	12	6	ISCE :60		40
			Total								

T. Y. B. Tech. Electronics and Telecommunication Engineering

Course code	R5ET3001T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	ELECTROMAGNETIC FIELDS AND WAVES						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply Maxwell's Equations for time-harmonic fields and the boundary conditions across media boundaries and use Gauss Law, Coulombs law and Poisson's Equations to find fields and potentials for a variety of situations including charge distributions and capacitors.
2. Analyze electromagnetic wave propagation and attenuation in various medium and propagation through boundaries between media.
3. Apply the basic properties of transmission lines; analyze electromagnetic wave propagation in generic transmission line geometries.
4. Design transmission lines; Impedance matching network for microwave systems and analysis of Computational Electromagnetic on communication products.

Module	Content	Hrs.
1	**Basics of Electromagnetics:** Introduction of coordinates system and Del operator, Electromagnetic filed Concept, Field Intensities, Current and Flux Densities, Differential and Integral form of Maxwell's Equations, Time Varying fields and its Applications, Boundary Conditions, Wave Equation and Polarization Theory.	10
2	**Plane Wave Propagation:** Introduction, Wave Equations, Plane Waves in Lossless Media, Plane Waves in Dielectric and Good Conductors, Group Velocity, Flow of Electromagnetic Power and the Poynting Vector, Normal and Oblique Incidence at a Plane Conducting Boundary and at Dielectric Boundary.	8
3	**Transmission Lines:** Introduction, Concept of Lumped/Distributed Elements, Characteristics impedance, Equations of Voltage and Current, Standing Waves and Impedance Transformation, Lossless and Low Loss transmission Lines, Power Transfer on a Transmission Line, Graphical Representation of a Transmission Lines with Impedance Smith Chart, Application of Transmission Lines, Impedance Matching with Single and Double Stub matching networks.	8
4	**Waveguides:** Introduction, Wave Equations, Transverse Magnetic (TM) Mode, Transverse Electric (TE) Mode, Transverse Electro-Magnetic (TEM) Mode, Rectangular Waveguides, Circular Waveguides	8
5	**Computational Electromagnetics:** Introduction of Finite-difference method, Finite-Element method, Method of Moments, Finite-Element one-dimensional analysis.	8

Text Book:

1. Devid J. Griffiths, *Introduction to Electrodynamics*, 4th Edition, Pearson Education India Learning Private Limited, 2015.
2. Edminister, *Schaum's series in Electromagnetics*, McGraw Hill, third edition, 1986.
3. R. K. Shevgaonkar., *Electromagnetic Waves* , McGraw Hill,2010.

Reference:

1. William Hayt, *Engineering Electromagnetics* , McGraw Hill, fourth edition, 1987.
2. Peter Russer, *Electromagnetics, Microwave Circuit and Antenna Design Communications Engineering*, Artech House, 2006.
3. Matthew N. O. Sadiku, *Elements of Electromagnetics* , second edition, Oxford university press, 1985.
4. Edward C. Jordan, Keith G. Balmain, *Electromagnetic Waves and Radiating Systems*, Second edition, Prentice-Hall,1968l.

Course code	R5ET3002T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	CONTROL SYSTEMS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Model various control system problems.
2. Improve performance and stability of the control system.
3. Improve stability of the system through frequency compensation.
4. Analyze and design state variable systems and various industrial controllers.

Module	Content	Hrs.
1	**Control system terminology & Mathematical Models of Physical Systems** Control system Terminology, classification of control system.Open loop and closed loop system, examples.Modeling of Electric systems and mechanical systems. Block diagram reduction Techniques and Signal flow graph.	8
2	**Time and Frequency domain Stability Analysis** Standard test signals.Time response of first order system and second order system. Transient specifications of second order system. Steady state specifications of second order system. Stability analysis – Routh-Hurwitz criterion. Root locus technique: applications, concept, construction of root loci. Bode Plot technique: applications, concept, construction of Bode plot	12
3	**Compensator Design** Introduction to Compensator: Derivative and integral error compensation. Analysis of the basic approaches to compensation, cascade compensation, feedback compensation. Electrical Lag, Lead, Lag-Lead compensator. Design Lag, Lead, Lag-Lead compensator using Root-locus. Design Lead, Lag, Lag-Lead compensator using Bode plot. PID design.	13
4	**State Variable Analysis** Concept of state, state variables and state model. State space representation of Continuous Time systems. Transfer function from State Variable Representation, Solutions of the state Equations. Concepts of Controllability and Observability	9

Text Book:

1. Noman S. Nise, *Control system Engineering*, Wiley, 8th Edition, 2024.
2. I. G. Nagarath, *Control System Engineering,* New age International Pvt. Ltd., 8th Edition, 2024.
3. Katsuhiko Ogata, *Modern Control engineering,* Pearson Edu. India, 5th Edition, 2015.
4. Karl J. Astrom, *PID controller: Theory, Design and tuning,* ISA, 2nd Edition, 1995.

Reference:

1. Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado, *Control System Design*, Pearson Edu. India, 1st Edition, 2015.
2. D. Roy Choudhury, *Modern Control Engineering,* Prentice Hall India Learning Pvt. Ltd, 2005.

Course code	R5ET3003T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DIGITAL SIGNAL PROCESSING						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Characterize digital signal processing system in various domains
2. Modeling digital signal processing systems and design various digital filters.
3. Analyze and design multirate digital processing system
4. Design and simulate digital signal processing hardware

Module	Content	Hrs.
1	**Frequency Domain Analysis of Discrete Time (DT) Systems** Pole-zero diagram, Frequency domain analysis using Analytical & graphical techniques, System classification based on pass-band as low pass, high pass, Band pass & band reject, System classification based on phase response as Minimum phase , maximum phase , mixed phase or linear phase systems.	8
2	**Analysis of DT system** DTFS & DTFT, Power & Energy density of periodic and aperiodic signals, Computation of DTFT, DFT. Properties of DFT, FFT, DIT, DIF. Connection between DTFT and Z-Transform.	8
3	**FIR Filter Design** FIR versus IIR filters, Design of FIR filters by windowing technique: (Gibb's phenomenon, Use of different windows: rectangular, triangular, Hamming, Hanning, Kaiser), Design of FIR filters using Frequency sampling techniques, Design of optimal linear phase FIR filters, Structures for implementation: canonic and lattice	8
4	**Design of IIR filters** The design process Methodology, Different types of analog approximations: Butterworth, Chebyshev, inverse Chebyshev, elliptical, Bessel etc., Spectral transformations, Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform, Intuitive approaches ,Structures for implementation: canonic and lattice,	8
5	**Multirate Sampling** Introduction, Decimation, Interpolation, Sampling rate conversion	4
6	**Wavelets** Review Fourier transform, Short-time Fourier transform. Time frequency resolution, orthogonality and orthonormality, Continuous time wavelet transform, discrete wavelet transform, Analysis using Haar scaling and wavelet functions, refinement relations.	6

Text Book:

1. Proakis Monolakis, *Digital signal processing* , 4th edition, Pearson,2007.
2. Antoniou, *Digital Filters Analysis, Design and Applications* 2nd edition, McGraw Hill Education ,1999.
3. R M Rao, A S Bopardikar, *Wavelets transforms*, Pearson Education,1998.
4. A. Nagoor Kani, *Digital Signal Processing*, McGraw-Hill Education Second edition 2013.
5. S.K. Mitra, *Digital Signal Processing: A Computer - Based Approach*, 4th edition, McGraw Hill Education,July 2013.

Reference:

1. Oppenheim Schafer, *Discrete Time signal processing,*3rd edition, Pearson, 2013.
2. Mitra, *Digital Signal processing A concept based Approach*, McGraw Hill,4e, 2016 by . McGraw Hill
3. Udayashankara, *Real Time digital signal processing Fundamentals, Algorithms and implementation using TMS processor*,PHI ,2010.
4. Ashok Ambardar, *Analog and Digital Signal Processing, Thomson Learning*, second edition, 2001.

Course code	R5ET3003L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	DIGITAL SIGNAL PROCESSING LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement and plot frequency response of FIR and IIR systems and obtain their transfer functions
2. Implement DIT-FFT and DIF-FFT
3. Design FIR & IIR filter.
4. Implement Wavelets and STFT based techniques for spectral analysis.

Sr.No.	Topics	
1	Frequency response of FIR and IIR system	
2	Transfer function and pole-zero plots of FIR and IIR systems	
3	Implementation DIT FFT and DIF FFT	
4	Magnitude & phase response for Four types of Linear Phase systems	
5	Design of FIR filters by windowing technique. [rectangular, triangular, hamming, hanning, Kaiser]	
6	Design of FIR filters using Frequency sampling techniques	
7	Design of IIR filters (a) Different types of analog approximations: Butterworth, Chebyshev, Inverse Chebyshev (b) Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform	
8	Implement Wavelets and STFT based techniques for spectral analysis	

Reference:

1. V.K. Ingle, John G. proakis, *Digital Signal processing*, 4th Edition,2015, Cengage learning Press.

Course code	R5ET3004T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	COMPUTER COMMUNICATION NETWORKS						Category: PCC

Course Outcomes:

After the completion of the course, the student should be able to

1. Define the network models, layered tasks, and protocols for data transmission.
2. Describe the concept related to Data Link Layer, Logical Link Control (LLC), and Medium Access Control (MAC) sub-layer
3. Estimate various parameters of the Network Layer, Transport Layer, and Application Layer.
4. Describe the concept of cloud computing.

Module	Content	Hrs
1	**Data Communication:** Components, Direction of Data flow, Networks, Types of connections, Topologies (Bus, Star, Ring, Mesh). Transmission Media – Twisted-Pair Cable, Coaxial Cable, Fibre Optics, Line Coding. Physical layer standards Basics of Message switching, Packet switching, Circuit switching and cell switching. Introduction to LAN, MAN, WAN	06
2	**Protocols And Standards:Standards –** ISO/OSI reference model, Overview of TCP/IP architecture, TCP/IP model, Structured cabling and specification: Standard CAT5, 5ERS232 Interfacing Standard. **Networking Devices:**Internetworking device- hub, repeater, bridge- spanning tree algorithm, switch, router Interfaces and connectors.Performance factors – Throughput, Bandwidth and Latency, High speed networks, Application performance needs.	08
3	**Data Link Layer and Logical Link Control (LLC) sub-layer:** Framing; Error control including Bit-parity, CRC and Hamming Codes; Reliable transmission and Automatic Repeat Request (ARQ) protocols including Stop-and-Wait, Go-back-N, and Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP. **Medium Access Control (MAC) sub-layer:** Random Access Protocols: CSMA, CSMA/CD, CSMA/CA, IEEE 802.3, IEEE 802.11; Related protocols such as ICMP, NAT, ARP and RARP, VLAN	08
4	**Network Layer:** Internet Protocol (IP) suite; Hierarchical network architectures; IPv4 and IPv6 addressing and headers; Routing protocols including distance-vector and link-state approaches; Interior and Exterior Gateway Protocol concepts; Routing Algorithms including Dijkstra's algorithm and distributed Bellman-Ford algorithm; Example protocols: OSPF, RIP, BGP.	08
5	**Transport Layer:** Reliable end-to-end transmission protocols; UDP header; Details of TCP header and operation including options headers and congestion control; Windows in TCP, TCP and UDP services. **Application Layer:** DHCP, DHCP operation, configuration, Domain Name System (DNS),Need for DNS, SMTP, FTP, and HTTP.	06
	Introduction to Cloud Computing:	

6	Cloud computing fundamentals, Types of Cloud Computing, Types of Cloud Services, cloud Deployment models, cloud security	06

Text Books:

1. Andrew Tanenbaum A. Forouzan, *Computer Networks* , Fifth Edition ,Person, 2010.
2. A. Forouzan, *Data Communication and networking ,* Fifth Edition, McGraw Hill Education, 2013.
3. Behrouz A. Forouzan, *TCP/IP Protocol Suite* , Fourth Edition, Tata McGraw Hill Education, 2010.

References:

1. Alberto Leon Garcia Indra Widjaja, *Communication networks Fundamental concepts and Key Architecture* **,** Second Edition, Tata Mc Graw Hill,2004.
2. Darren L Spohn, *Data Network Design* , Third Edition , Tata Mc Graw Hill.,2002.
3. Derrick Rountree, Ileana Castrillo , *The Basics of Cloud Computing* , Syngress,2013.

Course code	R5ET3004L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	COMPUTER COMMUNICATION NETWORKS LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Operate state of the art computer network simulation software.
2. Simulate the parameters of the Ethernet network.
3. Simulate parameters in the Token ring network and Implement the routing algorithm.
4. Design and test TCP/IP networks

Sr.No.	Topics	
1	To study configuration of different network connecting devices.	
2	To perform the basic networking commands.	
3	To implement and simulate different network topology by using Computer network simulator.	
4	To implement bit stuffing and Destuffing at the data link layer.	
5	To simulate Token Ring by using a Computer network simulator.	
6	To simulate collision detection by using a Computer network simulator	
7	To implement and examine performance of designed network via VLAN topology by using a Computer network simulator.	
8	To simulate Static Routing configuration by using a Computer network simulator.	
9	To implement and simulate Routing Information Protocol by using a Computer network simulator.	
10	To simulate Open Short Path First by using a Computer network simulator.	
11	Part A: simulate TCP and UDP Protocols by using a Computer network simulator. Part B: To learn about packet sniffers and see how they capture and analyze network traffic by using Wireshark	
12	Implementation of Virtualization in Cloud Computing to Learn Virtualization Basics, Benefits of Virtualization in Cloud using Open Source Operating System.	

Text Books:

1. Andrew Tanenbaum A. Forouzan, *Computer Networks* , Fifth Edition ,Pearson Education, 2010.
2. A. Forouzan, *Data Communication and networking ,* Fifth Edition, McGraw Hill Education ,2013
3. Behrouz A. Forouzan, TCP/IP Protocol Suite . Fourth Edition , Tata Mc Graw Hill.,2010

References:

1. Alberto Leon Garcia Indra Widjaja, *Communication networks Fundamental concepts and Key Architecture* , Second Edition, Tata Ma Graw Hill,2004
2. Darren L Spohn, *Data Network Design* , Third Edition , Tata Mc Graw Hill.,2002
3. Derrick Rountree, Ileana Castrillo , *The Basics of Cloud Computing* , Syngress,2013

Course code	R5ET3005T	Semester	V	Credits	2	Scheme	2L:0T:0P
Course	TELECOM NETWORK MANAGEMENT						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Acquire the knowledge about various network management tools and the skill to use them in monitoring a network
2. Describe the challenges faced by Network managers .
3. Evaluate various commercial network management systems and open network management systems.
4. Analyze and interpret the data provided by an NMS and take suitable actions.

Module	Content	Hrs
1	**Network Management Overview :** Case Histories of Networking and Management, Challenges of Information Technology Managers, Network Management: Goals, Organization, and Functions, Network Management System Platform, Current Status and future of Network Management.	5
2	**SNMP-v1 Network Management:** Communication and Functional Models ,The. Organization model. **SNMP MANAGEMENT:** Major Changes in SNMPv2,SNMPV3, SNMPv2 and SNMPV3 System architecture, The SNMPv2 Management Information Base	5
2	**SNMP Management: Rmon :** What is Remote Monitoring? ,RMON SMI and MIB, RMON1, RMON2, ATM Remote Monitoring, **Telecommunications Management Network:** Introduction, Operations Systems, TMN Conceptual Model, TMN Standards, TMN Architecture.	5
3	**Web-Based Management :** NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, **Web Services Distributed Management (WSDM) :**Management using Web-Services (MUWS) ,Management of web-services (MOWS).	5
4	**Principle of Telecommunication Traffic** Concept of Erlang, Quality of Service (QOS), Grade of service,	3
5	**Policy-based management:** Introduction to Policy-Based Management,Policy Frameworks and Standards**,**Policy Enforcement Mechanisms,Policy-Based QoS and Security. **Service Level Agreement (SLA) based management:** Introduction to SLA,Defining Service Scope and PerformanceMeasurable Metrics for SLA,Key components of an SLA,Types of SLA.Service-level agreement examples	5

Text Book:

1. Mani Subrahmanian, *Network Management Principles and Practice* , 2nd Edition, Pearson Education, 2010
2. Morris, *Network management* , 1st Edition, Pearson Education, 2008.

Reference Book:

1. Mark Burges, *Principles of Network System Administration* , 1st Edition, Wiley DreamTech, 2008.

Course code	R5ET3005L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	TELECOM NETWORK MANAGEMENT LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Analyze different performance parameters for the network.
2. Describe the performance in SNMP .
3. Acquire the knowledge of Web Based Enterprise Management.
4. Evaluate optimal scheduling algorithms for the SLA

Sr.No.	Topics
1	To learn different networking commands.
2	To monitor and analyze performance parameters by using network monitoring tool Lanstate Pro.
3	**Study of performance in Simple Network Management Protocol (SNMP)** a)Get request b) Set request c) Get next request d) Get bulk request e) Response f) Trap g) Inform Request
4	**Study of performance of Web Based Enterprise Management (WBEM)** 1. Desktop Management (DASH) 2. Network Management(Net Man) 3. Storage Management (SMI) 4.Systems Management (SMASH) 5. Virtualization Management(VMAM)
5	**Study of performance Web Services Distributed Management (WSDM)** Management using of Web-Services (MUWS) -Management of web-services (MOWS)
6	**Study of policy based management** a) Setting individual policies for such things as access to files or applications b) Various levels of access (read-only) or permission to update or delete files. c) The appearance and make-up of individual users' desktops and so on.
7	To study and verify the working of network protocol by using a network analyzer tool.
8	Study of X-tensible markup language a) Stream oriented APIs accessible from a programming language for (e.g. SAX and STAX) b) Tree- traversal API's is accessible from a programming language for.g. DOM. c) XML data binding which provides an automated translation between an XML document and Programming-language objects. d) Declarative transformation languages such as XSLT and XQUERY
9	**Study of Service Level Agreement (SLA) based management** a) Develop a framework for negotiating and establishing contact (SLA) between service providers and users. b) Develop a resource management system and optimal scheduling algorithms that support SLA- based allocation of resources to meet users QOS requirement management Automation

Text Book:

1. Mani Subrahmanian, *Network Management Principles and Practice* , 2nd Edition, Pearson Education, 2010.
2. Morris, *Network management* , 1st Edition, Pearson Education, 2008.

Reference Book:

1. Mark Burges, *Principles of Network System Administration* , 1st Edition, Wiley DreamTech, 2008.

Program Elective-I [3(Th)+1(L)CREDIT]

Course code	R5ET3101T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	MICROPROCESSOR SYSTEMS						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe architecture of 16-bit microprocessors.
2. Design microprocessor systems consisting of a 16-bit microprocessor/microcontroller, memory , I/O and other relevant devices.
3. Design and implement assembly language programs for 8086/ARM 7 microprocessors.
4. Design and implement I/O data transfer techniques.

Module	Content	Hrs
1	**Intel 8086/8088 microprocessor family** Architecture and organisation of 8086/8088 microprocessor family. Study of its Instruction set. Assembly language programming, 8086 family minimum and maximum mode operation. Timing diagram for 8086 family, detailed study of maximum mode connection: study of 8288 bus controller. 8086 interrupt structure.	6
2	**8086 Memory & I/O design:** Memory system design for 8086 family, timing considerations for memory interfacing. Connection of I/O Controllers 8255AH programmable peripheral Interface, Programmable Interrupt Controller 8259A, programmable D.M.A. Controller 8237	7
3	**8087 Math Co-processor** Study of architecture of 8087 floating point co- processor. Data types supported by 8087. Host and co - processor interface, Assembly language Programming for 8086 - 8087 based systems	7
4	**Introduction to 8086 based Multiprocessor systems:** Multiprocessor configurations. Study of the 8289 bus arbiter. Design of 8086 based multiprocessor systems (without timing considerations).	7
5	**ARM7TDMI Architecture** Architectural Block diagram and Features of ARM 7 TDMI, processor operating states, Memory formats, Data types, Operating modes, registers , Pipelining, Program status registers, exceptions, interrupt latencies. Memory system design.	7
6	**ARM7TDMI Assembly Language Programming** 8,16,32 bit and floating point numbers processing, Conversions between Hexadecimal, BCD, ASCII, Data movement/copy operations, block transfer of data, data swap/exchange Arithmetic, Logical, and Stack operation, loops, condition evaluation and decision making based on flags, control transfers (Call, Return, Jumps), processor state changing between ARM and THUMB, Exceptions, interrupts and its handling.	8

Text Book:

1. John Uffenback, 8086 / 8088 Design, *Programming and Interfacing*, second edition, ninth Indian reprint, Prentice Hall of India, 2001.
2. Sloss, Symes, Wright, *ARM System Developers Guide*- Elsevier Morgan Kaufman, first edition, 2004

Reference:

1. Douglas Hall, *Microprocessors Interfacing and Programming*, Tata McGraw Hill, third edition, 2002.
2. William Hohl, *ARM Assembly Language: Fundamentals and Techniques*, CRC press, 2009.

Course code	R5ET3101L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	MICROPROCESSOR SYSTEMS LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Write programs for data transfer, arithmetic and logic operations for 8086 microprocessors.
2. Write programs for data transfer, arithmetic and floating point operations for 8087 microprocessors.
3. Write programs for data transfer, arithmetic and logic operations and floating point operations for ARM 7 microprocessor.

Sr.No.	Topics	
1	**Module 1:** Any five programs on data transfer operations, Arithmetic & logic operations for 8086. 1.1 Data transfer for 8086. 1.2 Addition of two numbers. 1.3 Subtraction of two numbers. 1.4 Multiplication of two numbers 1.5 Division of two numbers 1.6 BCD Subtraction of 8 bit & 16 bit numbers. 1.7 Sorting of an array.	
2	**Module 2:** Any three programs on floating point operations involving 8087 2.1 Arithmetic operation on two single-precision floating-point numbers. 2.2 Find square root, trigonometric functions , absolute value, negation of a floating point number. 2.3 Multiply two 2×2 matrices with floating-point values using 8087. 2.4 Verify $\sin^2(x) + \cos^2(x) = 1.0$ for $x = 45°$	
3	**Module 3:** Any three programs on data transfer operations, arithmetic & logic operations and I/O involving ARM 7. 3.1 Data transfer for ARM 7. 3.2 Arithmetic operation on two numbers. 3.3 Conditional execution program. 3.4 Sorting of an array. 3.5 Multiply two 3×3 matrices.	

Text Book:

1. John Uffenback, "8086 / 8088 Design"*, Programming and Interfacing,* second edition, ninth Indian reprint, Prentice Hall of India, 2001.
2. William Hohl, A*RM Assembly Language: Fundamentals and Techniques*, CRC press, 2009.

Course code	R5ET3102T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	WIRELESS SENSOR NETWORKS						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concepts, network architectures and applications of ad hoc and wireless sensor networks.
2. Analyze the protocol design issues of ad hoc and sensor networks.
3. Describe the concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN.
4. Simulate routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues.

Module	Content	Hrs
1	**Overview Of Wireless Sensor Networks** Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Advantages of sensor networks- energy advantage, detection advantage, Sensor network applications- Habitat Monitoring, Tracking chemical plumes- Smart transportation.	8
2	**Architectures** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts	9
3	**Networking Sensors** Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts- S-MAC, The Mediation Device Protocol, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	9
4	**Infrastructure Establishment** Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	8
5	**Sensor Network Platforms And Tools** Sensor Node Hardware- Berkeley Motes, Programming Challenges, Node Level software platforms, Node-level Simulators, State-centric programming.	8

Text Book:

1. Holger Karl & Andreas Willig, *Protocols And Architectures for Wireless Sensor Networks* , John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, *Wireless Sensor Networks- An Information Processing Approach* , Elsevier, 2007.

Reference:

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, *Wireless Sensor Networks- Technology, Protocols, And Applications* , John Wiley, 2007.
2. Anna Hac, *Wireless Sensor Network Designs* , John Wiley, 2003
3. K. Akkaya and M. Younis, *A survey of routing protocols in wireless sensor networks* , Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325—349.

Course code	R5ET3102L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	WIRELESS SENSOR NETWORKS LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concepts, network architectures and applications of ad hoc and wireless sensor networks.
2. Analyze the protocol design issues of ad hoc and sensor networks.
3. Describe the concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN.
4. Simulate routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues.

Sr. No.	Topics	
1	To study various wireless sensor network architectures	
2	To simulate adhoc sensor network and compute performance metrics	
3	To implement and compare various MAC layer protocols.	
4	To implement and compare AODV and DSR routing algorithms in MANET.	
5	To implement DSDV routing algorithms in MANET	
6	Build a decentralized sensor network to monitor environmental data (e.g., temperature, humidity, air quality) across multiple nodes.	
7	Design an ad-hoc sensor network to detect motion or presence.	
8	Create an autonomous ad-hoc network for smart indoor lighting based on occupancy.	

Course code	R5EL3101T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DIGITAL VLSI DESIGN						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design of combinational and sequential circuits using MOS logic techniques, and assess their performance and reliability.
2. Write and simulate Verilog code for digital circuit implementation, using concurrent and Sequential constructs and synthesizable coding practices.
3. Apply digital system design principles, including FSMs, metastability, synchronization, and pipelining techniques.
4. Design FPGA-based systems by utilizing logic blocks, routing architecture, special resources, and timing constraints.
5. Perform testing and verification of digital circuits using fault modeling, DC/AC parametric tests, and other validation techniques

Module	Content	Hrs.
1	**Fundamentals of Digital VLSI Circuit Design** Introduction to MOS transistor theory, combinational circuit design, theory of logical efforts and interconnect delay, sequential circuit design, timing issues and power optimization, datapath subsystems, array subsystems	8
2	**Digital System Design** Introduction to Digital design; Hierarchical design, controller (FSM), FSM issues, timing issues, pipelining, resource sharing, metastability, synchronization, MTBF Analysis, setup/hold time of various types of flip-flops, synchronization between multiple clock domains, reset recovery, proper resets.	8
3	**HDL Basics** Introduction to Verilog and digital IC design CAD tools, Verilog operators, variables, and signal types, Structural, Data-flow, and Behavioral styles of hardware description, Concurrent and sequential constructs, loops, delay models, functions, coding for synthesis, test bench	10
4	**FPGA** Logic block and routing architecture, design methodology, special resources, Xilinx Spartan-6, Altera and Actel FPGAs, programming FPGA, constraints, STA, timing closure.	8
5	**Testing and Verification** Basics of testing and fault modelling: Introduction- Principle of testing - types of testing - DC and AC parametric tests - fault modelling	8

Text Book:

1. CMOS VLSI Design: A Circuits and Systems Perspective" by Neil Weste & David Harris
2. Samir Palnitkar, Verilog HDL: A Guide To Digital Design And Synthesis, Second Edition

Reference:

3. J. M Rabaey, A. Chandrakasan, B.Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson, 2012
4. J Bhasker, A Verilog Primer, Star Galaxy Publishing
5. N. Weste and K. Eshraghian, *Principles of CMOS VLSI Design*, Addison Wesley, 1993

Course code	R5EL3101L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	DIGITAL VLSI DESIGN LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and simulate arithmetic circuits (adders, multipliers) using HDL.
2. Implement and analyze combinational and sequential circuits, including multiplexers, decoders, flip-flops, and counters.
3. Develop and simulate FSMs for real-time digital logic applications.
4. Utilize HDL-based design methodologies for efficient digital circuit implementation.
5. Synthesize and deploy digital circuits on FPGA hardware, verifying their performance.

Sr.No.	Topics	
1	To design and simulate half and full adder using HDL code.	
2	To design and simulate ripple carry adder using HDL code.	
3	To design and simulate multipliers using HDL code.	
4	To design and simulate multiplexers, de-multiplexers, encoders and decoders using HDL code.	
5	To design and simulate different flip flops using HDL code.	
6	To design and simulate different synchronous counters using HDL code.	
7	To design and simulate different asynchronous counters using HDL code.	
8	To design and simulate different shift registers using HDL code.	
9	To design and simulate a Finite state machine using HDL code.	
10	To implement a digital circuit HDL code on an FPGA using HDL code.	
11	To design synchronous RAM with write Enable and Clock	
12	To design dual-port RAM using behavioral modelling for a 4-bit data width and a 3-bit address.	

Course code	R5EL3102T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DATA COMPRESSION AND ENCRYPTION						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement and evaluate various lossless and lossy compression methods.
2. Develop codes for text compression and estimate audio compressions
3. Develop and estimate image and video compressions
4. Analyze various quantization methods.
5. Describe different algorithms for encryption and decryption.

Module	Content	Hrs
1	**Data Compression Techniques** Loss less compression, Lossy compression, Entropy Measures of performance, Modeling and Coding Text Compression: Minimum variance Huffman coding, Extended Huffman coding, Adaptive Huffman coding, Shannon Fano Coding, Arithmetic coding Dictionary coding techniques, LZ 77, LZ 78, LZW ,File compression	8
2	**Audio Compression** High quality digital audio, Frequency, Spectral and Temporal masking, Lossy sound compression, Format of Compressed Data ,M-law and A-law companding, MPEG audio standard ,DPCM and ADPCM audio compression, Frequency Domain coding	9
3	**Image and Video Compression** Two D Image Transforms, Lossless Image compression techniques, PCM, DPCM, JPEG, JPEG –LS and JPEG 2000 standards ,Video Compression, Intra frame coding, motion estimation and compensation, Introduction to MPEG - 2 H-264 encoder and decoder, MPEG Industry Standards	8
4	**Quantization** Problems in quantization Uniform, adaptive, forward adaptive, backward adaptive, nonuniform quantization,Vector quantization and algorithms (Linde Buzo Gray algorithm, tree, pyramid, polar, lattice spherical quantization	9
5	**Encryption:** Different types of attacks,network security mechanism,substitution and transposition techniques,symmetric and asymmetric keys,DES ,AES algorithm,RSA,Diffie Hellman key exchange,Key management.	8

Text Book:

1. David Salomon, *Data Compression: The Complete Reference* ,4th edition , Springer Publication,2007.
2. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Series ,3rd Edition 2006.
3. Behrouz Forouzan, *Introduction to Cryptography and Network Security* ,McGraw-Hill Higher Education,1st edition,2008

Reference Book:

1. Mark Nelson, *The Data Compression Book* ,BPB publication 2nd Edition,1996.
2. Salomon, David, Motta, Glovanni., *Handbook of Data Compression* , Springer, Publications, 2010.

Course code	R5EL3102L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	DATA COMPRESSION AND ENCRYPTION LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Implement Lossless and Lossy compression algorithms and estimate parameters.
2. Implement text compression algorithms and estimate parameters.
3. Implement audio compression algorithm and estimate parameters.
4. Implement Image and video compression algorithms and estimate parameters.
5. Measure parameters of various quantization.

Lab Instructions: At least 2 experiments should be conducted on each module

Sr.No.	Topics	
1	**Data Compression Techniques** 1.1 Loss less compression and Lossy compression Implementation 1.2 Entropy Measures of Performance Simulation 1.3 Modeling and Coding Simulation 1.4 Text Compression Coding	
2	**Audio Compression** 2.1 Frequency, Spectral and Temporal masking Coding 2.2 M-law and A-law companding coding, 2.3 DPCM and ADPCM Implementation 2.4 Audio compression Implementation 2.5 Frequency Domain coding	
3	**Image and Video Compression** 3.1 Image Compression Implementation 3.2 Video Compression Implementation 3.3 MPEG encoder and decoder Simulation	
4	**Quantization** 4.1 LBG algorithm 4.2 Estimation of parameters in quantization	
5	**Data Encryption:** 5.1 To implement the DES and AES algorithm. 5.2 To implement the RSA algorithm.	

Course code	R5EL3103T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	IMAGE PROCESSING						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe theory and models in Image Processing.
2. Interpret and analyze 2D signals in frequency domain through image transforms.
3. Apply quantitative models of image processing for various engineering applications.
4. Develop innovative designs for practical applications of image processing in various fields.

Module	Content	Hrs
1	**Introduction: Image Fundamentals** Image acquisition, Image Digitization, sampling and quantization, image resolution, basic relationship between pixels, Image Formation Model, Geometrical transformation, Camera Modelling, Stereo vision, Colour images, RGB, HSI and other models, Different Imaging Modalities.	8
2	**Image Transforms** Discrete Fourier Transform, Discrete Cosine Transform, Walsh and Hadamard Transform, Haar Transform, Discrete Wavelet Transform, and its applications, slant transform.	9
3	**Image Enhancement Spatial Domain:** Point Processing: Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform, Histogram Equalization and Specification, Neighbourhood Processing: Averaging filters, order statistics filters, high pass filters and high boost filters, Frequency domain filtering.	8
4	**Image Segmentation** Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation Clustering Algorithms. Dilation, erosion, opening, closing, hit or miss transform, thinning and thickening, and boundary extraction on binary images.	9
5	**Image Compression** Image Compression Fundamentals, Image compression Model, Image Formats, Containers and Compression Standards, Huffman Coding, Arithmetic Coding, LZW Compression, Run Length Coding, Run-Length Coding, Bit-Plane Coding, Difference between Lossless Compression and Lossy Compression, Block Transform Coding, JPEG Compression, JPEG 2000.	8

Text Book:

1. Gonzalez and Woods, *Digital Image Processing* , Pearson Education, India, Third Edition.
2. Anil K.Jain, *Fundamentals of Image Processing* , Prentice Hall of India, First Edition, 1989.

Reference Book:

1. Murat Tekalp, *Digital Video Processing* , Pearson, 2010.
2. John W. Woods, *Multidimensional Signal, Image and Video Processing* , Academic Press 2012.
3. J.R.Ohm , *Multimedia Communication Technology* , Springer Publication.
4. A.I.Bovik, *Handbook on Image and Video Processing* , Academic Press.

Course code	R5EL3103L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	IMAGE PROCESSING LAB						Category: PCC

Course Outcomes:

After the completion of the course, the student should be able to

1. Implement different Image transform algorithms in Image Processing.
2. Implement different filtering algorithms used to enhance or restore images.
3. Implement different edge detection algorithms to study intensity progression in images.
4. Implement and study the morphological operations on images.
5. Implement algorithms to extract higher level features from images.

Sr.No.	Topics	
1	Implement the convolution operation on images	
2	Implement geometric transformations on images	
3	Implementation of Histogram based Techniques	
4	Implement Discrete Fourier Transform (DFT) and Inverse DFT on images.	
5	Generate the basis images of order N for Discrete Cosine Transform (DCT) and Walsh Transform. Also plot the basis images.	
6	Implement different filtering operations on images.	
7	Implement different edge detection techniques on images.	
8	Implement morphological operations on images.	
9	Implementation of feature extraction techniques on images.	

Text Book:

1. Gonzalez and Woods, *Digital Image Processing* , Pearson Education, India, Third Edition.
2. Anil K.Jain, *Fundamentals of Image Processing* , Prentice Hall of India, First Edition, 1989.

Reference Book:

1. Murat Tekalp, *Digital Video Processing* , Pearson, 2010.
2. John W. Woods, *Multidimensional Signal, Image and Video Processing* , Academic Press 2012.
3. J.R.Ohm , *Multimedia Communication Technology* , Springer Publication.
4. A.I.Bovik, *Handbook on Image and Video Processing* , Academic Press.

Course code	R5EL3104T	Semester	V	Credits	3	Scheme	2L:0T:0P
Course	INTRODUCTION TO ARTIFICIAL INTELLIGENCE						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe core AI concepts, including intelligent agents, search algorithms, knowledge representation, and machine learning paradigms.
2. Implement and compare different search algorithms for problem-solving.
3. Apply machine learning techniques to build and train models for prediction and pattern recognition.
4. Evaluate the performance of AI systems and discuss their limitations.

Module	Content	Hrs.
1	**Introduction to Artificial Intelligence** What is AI? Definitions, history, and applications of AI. Intelligent Agents: Rationality, types of agents, and agent architectures. Problem Solving: Problem formulation, search space, and search strategies. Applications in E&TC: AI in communication systems, signal processing, network optimization, etc.	8
2	**Search Techniques** Uninformed Search: Breadth-first search, depth-first search, uniform cost search. Informed Search: Heuristic search, A search, greedy best-first search. Local Search: Hill climbing simulated annealing, genetic algorithms. Constraint Satisfaction Problems: CSPs, backtracking, constraint propagation.	8
3	**Knowledge Representation and Reasoning** Propositional Logic: Syntax, semantics, inference rules, resolution. Predicate Logic: First-order logic, quantifiers, unification, and resolution. Semantic Networks: Representing relationships and concepts. Ontologies: Knowledge representation frameworks, description logic. Reasoning under Uncertainty: Probabilistic reasoning, Bayesian networks.	9
4	**Machine Learning** Introduction to Machine Learning: Supervised, unsupervised, and reinforcement learning. Supervised Learning: Classification (KNN, decision trees, support vector machines), regression (linear regression, polynomial regression). Unsupervised Learning: Clustering (k-means, hierarchical clustering), dimensionality reduction (PCA). Reinforcement Learning: Markov decision processes, Q-learning.	9
5	**Applications of AI in Electronics** AI in Communication Systems: Channel modelling, signal detection, network routing. AI in Signal Processing: Speech recognition, image processing, pattern recognition. AI in Robotics: Robot control, path planning, computer vision. AI in IoT: Smart devices, data analytics, predictive maintenance.	8

Text Book:

1. Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. pearson, 2016.
2. Knight, Kevin, and Elaine Rich B. Nair Artificial Intelligence, 2017.

Reference:

1. Ertel, Wolfgang, Introduction to artificial intelligence. Springer Nature, 2024.
2. Nilsson, Nils J. , *Principles of artificial intelligence*. Morgan Kaufmann, 2014.

Course code	R5EL3104L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	INTRODUCTION TO ARTIFICIAL INTELLIGENCE LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement fundamental AI algorithms such as search techniques, heuristic methods, and optimization algorithms.
2. Apply machine learning models for classification, clustering, and prediction using real-world datasets.
3. Analyze and evaluate AI models based on accuracy, efficiency, and computational complexity.
4. Utilize AI frameworks and tools like Python (NumPy, Pandas), TensorFlow, and OpenCV for practical implementations.

Sr.No.	Topics	
1	Python Programming for AI: Introduction to Python and essential libraries like NumPy and Pandas.	
2	Search Algorithm Implementation: Coding and testing BFS and DFS algorithms.	
3	An Algorithm Application*: Solving shortest path problems using the A* algorithm.	
4	Constraint Satisfaction Solver: Developing solutions for Sudoku or similar puzzles.	
5	Bayesian Network Modelling: Constructing and inferring Bayesian networks.	
6	Supervised Learning Models: Implementing linear regression and classification tasks.	
7	Clustering Techniques: Applying K-Means clustering to group data sets.	
8	Reinforcement Learning Simulation: Creating simple game simulations to apply reinforcement learning.	
9	AI in Signal Processing: Using AI for noise filtering in audio signals.	
10	Network Traffic Prediction: Applying machine learning to forecast network usage patterns.	
11	AI-Driven Embedded Application: Developing a smart IoT prototype with embedded AI capabilities.	
12	Ethical Case Study Analysis: Evaluating real-world AI applications and their ethical considerations.	

Text Book:

1. Russell, Stuart J., and Peter Norvig. *Artificial intelligence: a modern approach*. pearson, 2016.
2. Knight, Kevin, and Elaine Rich B. Nair *Artificial Intelligence,* 2017.

Reference:

1. Ertel, Wolfgang. *Introduction to artificial intelligence*. Springer Nature, 2024.
2. Nilsson, Nils J. *Principles of artificial intelligence*. Morgan Kaufmann, 2014.

MDM-III:Minor in Electronics & Communication

Course code	R5ET3202T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	PRINCIPLES OF COMMUNICATION SYSTEMS						Category: MDM

Course Outcomes:

After the completion of the course, the student should be able to

1. Describe basic analog communication processes.
2. Describe and solve problems on modulation.
3. Analyze transmitter and receiver circuits.
4. Analyze and interpret pulse analog techniques.

Module	Content	Hrs
1	**Basics of Communication Systems** Block diagram, electromagnetic spectrum, signal bandwidth, and power, types of communication channels, Introduction to time and frequency domain, Types of noise, signal-to-noise ratio, noise figure, and noise temperature.	6
2	**Amplitude Modulation and Demodulation** DSB Full carrier AM – principles, modulator circuits, transmitters, different types of AM modulators, Suppressed–carrier AM, SSB– Principles, transmitters. Receiver characteristics, TRF and Super-heterodyne receivers, AM detectors.	10
3	**Angle Modulation and Demodulation** Frequency modulation, Phase modulation, Effect of noise, FM modulators, Transmitters, FM detectors, Limiter , Receiver circuits.	10
4	**Radio Receivers** TRF, Super - heterodyne receiver, receiver parameters and choice of IF, AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver, FM receiver circuits, comparison with AM receiver	8
5	**Analog Pulse Modulation** Sampling Theorem for Low – pass, and Band – pass signals – proof with spectrum Aliasing. Sampling Techniques principle, generation, Demodulation, spectrum. PAM, PWM, PPM – generation and detection.	8

Text Books

1. Roy Blake, *Electronic Communication Systems*, Thomson Asia Pte. Ltd., Singapore, 2nd edition, 2001.
2. Kennedy and Davis, *Electronics communication system*, Tata McGraw Hill, 5th Edition,2011.

Reference:

1. B.P. Lathi, *Modern Digital And Analog Communication Systems*, Oxford,4th Edition, 2011.
2. Herbert Taub and Donald Schilling, *Principles of Communication Systems*, Tata McGraw-Hill, 3rd edition,2007.

MDM-III:Minor in Cyber Security

Course code	R5ET3201T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	NETWORK SECURITY						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the network security, services, attacks, mechanisms, types of attacks on TCP/IP protocol suite.
2. Implement the concepts of IP Security and Email Security.
3. Analyse the mitigation techniques to reduce the risk of cyber-attacks on web applications
4. Describe the security vulnerabilities in Wireless LAN and defense mechanisms against such vulnerabilities

Module	Content	Hrs
1	**Introduction to Network Security:**Network security models, Security services, attacks, Security Issues in TCP/IP suite- Sniffing, spoofing, buffer overflow, ICMP Exploits, IP address spoofing, IP fragment attack, routing exploits, UDP exploits, TCP exploits**.** Real-time Communication Security.	06
2	**IP Security and Email Security:** IP Security architecture, Authentication header, Encapsulating security payload, SSL/TLS,SSH. Email Security: Types of Email threats, Email Security Policies**,** Email security protocols, Pretty Good Privacy (PGP),S/MIME, Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall.	8
3	**Network Device Vulnerabilities:**Media- Based-Vulnerabilities, Network Device Vulnerabilities, Back Doors, Denial of Service (DoS), Spoofing, Man-in-the-Middle, and replay, Protocol - DNS Spoofing, DNS Poisoning, ARP Poisoning, TCP/IP Hijacking, Virtual LAN (VLAN), Demilitarization Zone (DMZ) , Network Access Control (NAC), Proxy Server , Honey Pot , Network Intrusion Detection Systems (NIDS) and Host Network Intrusion Prevention Systems Protocol Analyzers, Internet Content Filters, Integrated Network Security Hardware .	10
4	**Web security:** Security architecture of World Wide Web, Security Architecture of Web Servers, and Web Clients, Web Application Security – Cross Site Scripting Attacks, Cross Site Request Forgery, SQL Injection Attacks, content Security Policies (CSP) in web Session Management and User Authentication, Session Integrity, Https, SSL/TLS	10
5	**Wireless Network Security:**Security Attack issues specific to Wireless systems: Worm hole, Tunnelling, DoS, WEP for Wifi Network, Security for Broadband networks: Secure Adhoc Network, Secure Sensor Networks,wireless communication security	08

Text Books:

1. Behrouz A. Forouzan, *Cryptography and Network security*, Tata McGraw- Hill, 2008.
2. William Stallings, *Cryptography and Network security: Principles and Practice* , 2nd Edition, Prentice Hall of India, New Delhi, 2002.
3. Atul Kahate*, Cryptography and Network security* , 2nd Edition, Tata McGraw-Hill, 2008.

References:

1. H. Yang et al., *Security in Mobile Ad Hoc Networks: Challenges and Solution* , IEEE Wireless Communications, Feb. 2004
2. David Boel et.al (Jan 2008), *Securing Wireless Sensor Networks*, Security Architecture Journal of networks , Vol. 3. No. 1. pp. 65 -76.
3. Perrig, A., Stankovic, J., Wagner, D. (2004), *Security in Wireless Sensor networks, Communications of the ACM*, 47(6), 53-57.

SEMESTER -VI

Course code	R5ET3006T	Semester	VI	Credits	2	Scheme	2L:0T:0P
Course	MICROWAVE COMMUNICATION						Category: PCC

Course Outcomes:

After the completion of the course, the student should be able to

1. Identify the use of microwave components and devices in microwave applications.
2. Estimate parameters of all the solid-state microwave devices
3. Analyze the microwave passive circuit components and design the tuning and matching networks
4. Design of microwave amplifiers and expertise in microwave generation and measurement.

Module	Content	Hrs
1	**Introduction**: Microwave bands, Characteristics of microwaves, Microwave systems, traditional, Industrial, and Biomedical applications, Microwave hazards.	4
2	**Passive And Active Microwave Devices:** Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, circulators, and Isolators. Crystal and Schottky diode, PIN diode switch, Gunn diode oscillator, IMPATT diode, Varactor diode, Microwave tunnel diodes, Klystron Amplifier, Reflex Klystron oscillator, Travelling wave tube amplifier, Magnetron,	6
3	**Representation of Two-Port Networks:** Introduction, impedance, admittance, hybrid and ABCD matrices, traveling waves, and transmission line concepts. Scattering matrix and the chain scattering matrix, shifting reference plans, properties of scattering parameters, generalized scattering parameters, two-port network parameters conversions, and scattering parameters of transistors. Design of Matching Circuits Using Lumped Elements.	6
4	**Microwave Amplifier:** Introduction, powers gain equations, Stability consideration, constant gain circles unilateral case, and unilateral figure of merit, operating and available power gain. Introduction to noise in two-port networks, constant noise figure circles, broadband amplifier design. Parametric amplifiers, Low Noise amplifiers.	5
5	**Microwave Oscillator:** Introduction, compressed Smith chart, Introduction, part negative– resistance oscillators, two-part negative resistance oscillator, oscillator design using large signal measurements. **Microwave measurements:** Measuring Instruments: Principle of operation and application of VSWR meter, Power meter, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Attenuation, Directional coupler.	7

Text Book:

1. Samuel Liao, *Microwave Devices and Circuits* , 3rd edition, PHI Publication.
2. David Pozar, *Microwave Engineering* , 4th edition, John Wiley and Sons publication, 2012.
3. Peter A. Rizzi., *Microwave Engineering Passive Circuits* , PHI publication, 1988.
4. Annapurna Das and Sisir K Das, *Microwave Engineering* , Tata McGraw Hill Publishing Company Ltd, New Delhi, 2005.

Reference:

1. *Microwave Transistor Amplifiers: Analysis and Design*; 2/e, 2007 by G. Gonzalez Prentice Hall of India.
2. *Electromagnetic Field theory fundamentals*-1998 by Guru and Hisiroglu. Thomson Learning publication.
3. *Modern RF and Microwave Measurement Techniques*, by Valeria Teppati. Cambridge.
4. *Basic Microwave Techniques and Laboratory Manual* 1987 by M.L.Sisodia, G.S.Raghuvamsi. Wiley Eastern Limited publication.

Course code	R5ET3006L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	MICROWAVE COMMUNICATION LAB						Category: PCC

Course Outcomes:

After the completion of the course, the student should be able to

1. Measure the parameters of waveguide and waveguide components.
2. Measure various parameters of microwave semiconductor devices and expertise in microwave measurement.
3. Design planar-line sections for Microwave circuits.
4. Use microwave simulator tools

Sr.No.	Topics	
1	Microwave Measurements: Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Attenuation.	
2	Measurement of E-plane and H-plane characteristics	
3	Microwave devices parameter measurements: S-parameter measurements of two-port networks, Magic Tee, isolator directional coupler.	
4	Microwave software design tools: Introduction to Microwave circuit simulator, CADFEKO, SONNET, MULTISIM, SMITHV, etc.	
5	GUNN diode characteristics.	
6	Reflex Klystron Mode Characteristics.	
7	Directional Coupler Characteristics.	
8	Unknown load impedance measurement using Smith chart and verification using transmission line equation	

Course code	R5EL3007T	Semester	VI	Credits	2	Scheme	2L:0T:0P
Course	EMBEDDED SYSTEMS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the software architecture of embedded system.
2. Identify the necessary communication Interface for the embedded system.
3. Implement systems softwares and application software related to real-time systems.
4. Design and develop the small-scale embedded systems.

Module	Content	Hrs
1	**Introduction to Embedded system** Introduction To Embedded Systems , Classification, Major Application Areas, Purpose Of Embedded Systems, Characteristics And Quality Attributes Of Embedded Systems.	2
2	**Software Architecture of Embedded System** Software Architecture: Services Provided By OS, Architecture Of Embedded OS, Categories Of Embedded OS, Application Software, Communication Software, Development And Testing Tools.	3
3	**Communication Interfaces** Need For Communication Interfaces, OSI Reference Model, Basic Of Networks, Network Topology, RS232/UART,RS422/RS485, USB,Infrared, Ethernet, IEEE 802.11, Bluetooth, SPI, I2C, CAN, Wifi, Flex Ray, LIN Bus, Zigbee. Galvanic Isolation and its importance.	6
4	**Embedded Software** Software Developments Tools, Cross Platform Development, Programming Languages Like Embedded C, Embedded C++ And J2ME , Device Drivers, Debuggers, Profilers, Code Optimization, Overview Of RTOS, Architecture Of Kernel, Task & Task Scheduler, ISR, Semaphore, Mutex, Mailbox, Message Queues, Event Registers, Pipes, Signals, Timers, Memory Management, Priority Inversion Problem.	6
5	**Embedded System Development & Testing** Different Embedded System Development Models, Requirement Engineering, Design Tradeoff, Co-Design, Hardware Design, Software Design, Implementation, Integration & Testing, Packaging, Configuration Management, Managing Embedded System Development Projects, Embedded System Failures.	6
6	**Design Examples & Case Studies of Embedded System** Digital Thermometer, Navigation Systems, Smart Card, RF Tag	5

Text Book:

1. Raj Kamal , *Embedded system ,* Third edition, Tata McGraw Hill, 2017.
2. Prasad , *Embedded Real time systems*,1st edition Dream tech press.2003

Reference:

1. David Simon, *An embedded Software Primer*, Pearson Publication, 2002.
2. Frank Vahid, *Embedded system- A unified Hardware Software Introduction*, John Wiley and Sons, 2002.

Course code	R5EL3007L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	EMBEDDED SYSTEMS LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and implement programs on 8051 microcontroller and its derivatives
2. Connect sensors and implement programs using them
3. Using RTOS in embedded projects
4. Design build and test an embedded product

Lab Instructions: At least 1-2 experiments should be conducted on each topic

Sr.No.	Topics	
1	**Embedded Software Development Tools:** 1.1 Use Keil µVision 4/5 to create, compile, and flash a simple LED blink program on an 8051 derivative. 1.2 Enhance the blink project by using Timer 0 (in auto-reload mode) and interrupts to toggle the LED. 1.3 Build a visual flowchart-based application in Flowcode. 1.4 Develop, compile, and upload a basic Arduino sketch using the Arduino IDE.	
2	**Embedded sensors and peripheral modules:** Test several sensors and peripherals modules with 8051 and Arduino UNO boards.	
3	**Deployment of embedded system:** Deployment of software into hardware and testing hardware, software and hardware with software and measure design parameters	
4	**RTOS:** Study of Various Commands of RTOS like RTX51 tiny, Free RTOS, RTLinux and programming and develop multitasking software applications.	
5	**Embedded system design and implementation :** Design, build and test embedded product for various embedded applications using development systems and open source platforms.	

Text Book:

1. Raj Kamal , *Embedded system ,* Third edition, Tata McGraw Hill, 2017.
2. Prasad , *Embedded Real time systems*,1st edition Dream tech press.2003

Reference:

1. Mazidi, *8051 microcontroller and embedded system*, 2nd Edition, Pearson,2007.
2. Cornel Amariei, *Arduino Development Cookbook,*standard edition, Packt publishing, 2015.

Course code	R5ET3008T	Semester	VI	Credits	2	Scheme	2L:0T:0P
Course	WIRELESS COMMUNICATION						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Design a cellular system.
2. Characterize different indoor and outdoor propagation models related to losses and different types of fading.
3. Describe GSM, CDMA concepts and architecture, frame structure, system capacity, services provided.
4. Describe the concept of MIMO, 4 G and 5G architecture, 5G spectrum requirement.

Module	Content	Hrs
1	**Fundamentals of Mobile Communication:** Introduction to Wireless Communication: Mobile Radio Telephony, Examples of Wireless Communication Systems. The Cellular Concept System Design Fundamentals: Frequency reuse, Channel assignment strategies, Interference and system capacity, Trunking and Grade of service, Improving Coverage and Capacity in Cellular System and related problems.	7
2	**Mobile Radio Propagation:** Study of indoor and outdoor propagation models. Small scale and multi-path fading parameter of multi-path channels	4
3	**2G and 3G Technologies:** GSM: GSM Network Architecture, air interface specifications, GSM signaling protocol architecture, GSM channels, GSM services and features, GSM multiframe structure, GSM speech coding, GSM Call procedures,Authentication and security in GSM, and handoff procedures in GSM. IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver. W-CDMA air interface, attributes of WCDMA system, W-CDMA channels. Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.	7
4	**Advanced techniques for 4G deployment and beyond :** 4G Introduction, 4G architecture, protocol structure, Frame slots and symbols, OFDM , coding, Logical and Physical Channels, Multi antenna Technologies in 4G, software defined radios (SDR), security in 4G.	6
5	**Introduction to 5G network:** 5G architecture, 5G Frame structure, Massive MIMO, Beamforming, NOMA,5-G NR, and 5 G radio spectrum, 5G Radio access technologies, Security in 5 G.	4

Text Book:

1. Rappaport,T.S., Wireless communications , 2nd Edition, Pearson Education,2010
2. Clint Smith, P.E Daniel Collins, 3G Wireless Networks ,Mc Graw Hill, 2nd Edition ,2014.
3. Vijay Garg , Wireless Communications and networking , 1st Edition,Elsevier 2007

Reference:

1. Young Kyun Kim and Ramjee Prasad, 4 G Roadmap and Emerging Communication Technologies , 3rd Edition ,Artech house.2006.
2. Raj Pandya, Mobile And Personal Communications Systems And Services , Prentice hall, 3rd Edition , 2000.
3. Upena Dalal, Wireless Communication , 1st Edition ,Oxford University Press, 2009.

Course code	R5ET3008L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	WIRELESS COMMUNICATION LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concept of cellular systems.
2. Simulate and estimate parameters of indoor and outdoor propagation model.
3. Analyse working of GSM and CDMA transmitter and receiver systems.
4. Examine the multicarrier techniques and new waveform options for 4G and 5G communication.

Sr.No.	Topics	
1	To Describe the cellular frequency reuse concept to find the co-channel cells for a particular cell.	
2	To simulate Free Space Propagation – Path Loss Model.	
3	To simulate Outdoor Propagation – Okumura Model.	
4	To simulate Outdoor Propagation – Hata Model	
5	To simulate the design of a filter for implementing the GSM modulation technique in 03 GMSK.	
6	To perform DSSS using PN sequence.	
7	To generate Walsh matrix using Hadamard matrix.	
8	To perform waveform generation for OFDM .	
9	4G-Compliant waveform generation and testing	
10	5G-Compliant waveform generation and testing	

Text Books:

1. Rappaport,T.S., Wireless communications , 2nd Edition, Pearson Education,2010
2. Clint Smith, P.E Daniel Collins, 3G Wireless Networks ,Mc Graw Hill, 2nd Edition ,2014.
3. Vijay Garg , Wireless Communications and networking , 1st Edition, Elsevier 2007.

References:

1. Young Kyun Kim and Ramjee Prasad, 4 G Roadmap and Emerging Communication Technologies , 3rd Edition ,Artech house.2006.
2. Raj Pandya, Mobile And Personal Communications Systems And Services , Prentice hall, 3rd Edition , 2000.
3. Upena Dalal, Wireless Communication , 1st Edition ,Oxford University Press, 2009.

Course code	R5ET3401T	Semester	VI	Credits	2	Scheme	1L:0T:2P
Course	COMMUNICATION IN SERVICE TO SOCIETY						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Analyze the needs of various sections of society who can benefit from Electronic interventions.
2. Translate the need into an idea of electronic systems.
3. Design and implement electronic systems using analog and digital components and sensors / transducers.

Module	Content	Hrs
1	**Analysis of an electronic aid / instrument / system** Requirements analysis to gather inputs to Describe needs of various sections of society. Describe Government of India Schemes like - Make in India, Digital India, Start up India, Stand up India, Smart cities mission, Electronic manufacturing mission, Software parks, hardware parks, Facilities and support provided by various government agencies for these schemes.	7
2	**Design, fabricate and test an electronic system** Describe UN sustainable development goals. Design, fabricate, implement and test an electronic system with both analog and digital electronic components which will be a prototype of a product useful to society and confirming to UN sustainable development goals.	7

Program Elective-II [3(Th)+1(L) CREDIT]

Course code	R5ET3103T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	BASICS OF IOT						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Define the Internet of Things and its components.
2. Perform IoT Systems management
3. Design IoT systems
4. Analyse the system through Data Analytics tools.

Module	Content	Hrs.
1	**Introduction to IoT** Background and Vision; IoT as a Disruptive Technology; Standardization; Thing in the context of IoT; Needs of an IoT; Commonly used smart Things; Machine to Machine (M2M) Technology	6
2	**IoT Standards and Protocols** An overview of Internet Principles; IPv6 and Its Role in IoT; Low Power Wide Area Network (LPWAN); Wireless Technologies supporting IoT applications	6
3	**Wireless Sensor Networks in IoT** Types of WSN and Their Architecture; Characteristics of Wireless Sensor Network; Network Topologies in Wireless Sensor Network; WSN Communication Protocols; Security in WSN; Distributed Sensor Network; Wireless Sensor Network Data Aggregation Approaches; Real World WSN Applications	8
4	**Sensors, Actuators and Open Hardware in IoT:** Introduction of sensors for different IoT applications, Perception Layer of IoT; Active sensors vs Passive Sensors; Understanding Various Commonly Used Sensors eg.: Light sensor, accelerometer, gyroscope, magnetometer, proximity, RFID; Environment Measuring Sensors; Flow and Fluid Measuring Sensors; Range and Motion Capture Sensors; Actuators; IoT Examples IoT Hardware; Prototyping Boards/Kits for IOT - Arduino and Raspberry-pi; Hardware for Cellular IoT	8
5	**IoT Middleware and Software Platforms** Introduction to Middleware; Functional and Non-functional Requirements of IoTMiddleware; Architectures of IoT Middleware; State-of-the-art IoTMiddleware - OpenIoT, Node-RED, Google Cloud IoT. Introduction to IoT Software Platforms; Need and characteristics of IoT Platform, Commercial IoT Software Platforms - AWS, IBM Watson IoT Platform, Microsoft Azure IoT suite; Open IoT Software Platforms- things board and things.io; Important considerations for selection of IoT Platform.	7
6	Arduino Programming Building Blocks – Basics, Internet Connectivity, Communication Protocols. IoT Patterns: Real-time Clients, Remote control, On-demand Clients, Web Apps: Machine to Human, Machine to Machine, Platforms	7

Text Book:

1. Surya Durbha and Jyoti Joglekar, *Internet of Things,* Oxford University press, 2021

Reference:

1. Cuno Pfister, *Getting Started with the Internet of Thing*s, O'Reilly Media,2011.
2. Arshdeep Baga and Vijay Madisetti, *Internet of things*, A hands-on approach.

Course code	R5ET3103L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	BASICS OF IOT LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and implement circuits to interface sensors, actuators, and communication modules with IOT based embedded platforms
2. Implement wireless communication protocols for IOT platforms
3. Design and prototype basic IoT applications
4. Implement cloud based IOT applications

Sr.No.	Topics	
1	Interfacing LED and Switch with Arduino and Raspberry pi.	
2	Interfacing Light dependent Resistor (LDR), Infrared Sensor with Arduino Uno/ raspberry pi.	
3	Interfacing ultrasonic, GPS, DHT22 sensor using ESP32.	
4	Interfacing of water sensor, Air quality sensor,collision sensor using arduino UNO/ Raspberry pi.	
5	Interfacing of thumb joystick using arduino uno.	
6	Study of zigbee and BLUEtooth protocol using Arduino/ ESP 32.	
7	Implementation of a home automation system raspberry pi.	
8	Implementation of a weather monitoring system using raspberry pi.	
9	To interface a temperature and humidity sensor and acquire data using Node-RED and display it on a real-time dashboard.	
10	To securely publish environmental sensor data from ESP32 to Cloud Platform (such as Google cloud, microsoft azure ,Amazon aws) using MQTT	

Reference:

1. Schwartz, Marco, *Internet of Things with Arduino Cookbook*, United Kingdom: Packt Publishing, 2016.
2. Michael Margolis, *Arduino Cookbook,* O'Reilly Media, Inc. , 2011

Course code	R5ET3104T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	NEXT GENERATION NETWORKS						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. State the technical features and design considerations of the next generation mobile networks.
2. Compare the Various IMS Services
3. Describe the common technologies used in the core, distribution and access layers.
4. Design a network with good capacity and efficiency.

Module	Content	Hrs
1	**Introduction** Evolution of public mobile services - motivations for IP based services, Wireless IP network Architecture – 3GPP packet data network architecture, Introduction to next generation networks -Changes, Opportunities and Challenges, Technologies, Networks, and Services, Next Generation Society, future Trends	9
2	**IMS and Convergent Management** IMS Architecture - IMS services, QoS Control and Authentication, Network and Service management for NGN, IMS advantages, Next Generation OSS Architecture - standards important to OSS architecture, Information framework, OSS interaction with IMS, NGN OSS function/ information view reference model, DMTF CIM.	9
3	**MPLS AND VPN** Technology overview –MPLS &QoS, MPLS services and components – layer 2 VPN, layer 2 Internet working, VPN services, signaling, layer 3 VPN –Technology overview, Remote Access and IPsec integration with MPLS VPN.	8
4	**Multicast** MPLS Multicast VPN overview – Applications, examples, IPv6 and MPLS - Technology overview, Future of MPLS – Integrating IP and optical networks, Future layer 3 services, future layer 2 services.	8
5	**NGN Management** Network Management and Provisioning – Configuration, Accounting, performance, security, case study for MPLS, Future enhancements – Adaptive self-healing networks.	8

Text Book:

1. Thomas Plavyk, ―Next generation Telecommunication Networks, Services and Management‖, Wiley& IEEE Press Publications, 2002.
2. Neill Wilkinson, ―Next Generation Network Services‖, John Wiley 2002

Reference:

1. Monique J. Morrow, ―Next Generation Networks‖, CISCO Press, 2007.
2. Robert Wood, ―MPLS and Next Generation Networks: Foundations for NGN and Enterprise Virtualization", CISCO Press, 2006.

Course code	R5ET3104L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	NEXT GENERATION NETWORKS LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Analyze different network performance parameters for IP based mobile services.
2. Implement authentication mechanism in IMS networks.
3. Implement the concept of Layer 2 &3 VPN using MPLS.
4. Demonstrate the ability to integrate advanced security and addressing mechanisms in MPLS networks by configuring IPsec.

Sr. No.	Topics	
1	Network Performance Analysis of IP-based Mobile Services.{ NS3 or GNS3, IP packet analyzers like Wireshark}	
2	Simulation of 3GPP Packet Data Network Architecture.{NS3, OMNeT++, or MATLAB.}	
3	Authentication Mechanisms in IMS Networks {Open IMS Core, Wireshark, OpenSSL for testing TLS/SSL security}	
4	OSS Integration with IMS for Fault Management {OSS/BSS simulation platforms, Open IMS Core, SNMP or NETCONF for fault management.}	
5	Implementing Layer 2 VPN with MPLS {Cisco routers, GNS3, or real MPLS routers.}	
6	MPLS Layer 3 VPN – Routing and Segmentation	
7	IPsec Integration with MPLS VPNs	
8	Explore the coexistence of IPv6 in MPLS networks.	

Course code	R5EL3106T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	INTRODUCTION TO MICROFABRICATION						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Explain the process of crystal growth and wafer preparation, including cleanroom requirements and wafer cleaning techniques.
2. Describe the principles and mechanisms of oxidation, lithography and etching in semiconductor manufacturing processes and their impact on device performance.
3. Demonstrate an understanding of thin-film deposition methods and diffusion techniques used in IC fabrication.
4. Evaluate the significance of metallization and interconnects in semiconductor device performance and reliability.

Module	Content	Hrs.
1	**Crystal Growth & Wafer Preparation** History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS.Crystal Growth, Wafer Preparation, Clean room and Wafer Cleaning: Definition, Need of Clean Room.	10
2	**Oxidation** Dry and Wet Oxidation, Oxidation Rate Constants, Dopant Redistribution, LOCOS, Oxidation System	9
3	**Lithography & Etching** Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Depth of Focus, Advanced Lithography. Etching: Wet Etching, Plasma Etching, Reactive Ion Etching. Overview of Interconnects, Contacts, Metallization	11
4	**Deposition & Diffusion** Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Sputtering, Chemical Vapor Deposition, Plasma Enhanced CVD, Atomic layer deposition (ALD). Diffusion: Dose, 2-Step Diffusions, Junction Depth, Diffusion System. Ion Implantation, Applications in ICs, Annealing.	12

Text Book:

1. James D. Plummer, Michael D. Deal, Peter B. Griffin, *Silicon VLSI Technology-Fundamentals*, Practice, and Modeling, Prentice Hall Electronics and VLSI Series, 2000.

Reference:

1. Sorab K Gandhi, *VLSI Fabrication Principles: Silicon and Gallium ArsenideI*, 2nd Edition, Wiley,2008.
2. S. M. Sze, M. K. Lee, *Semiconductor Devices: Physics & Technology*, 3rd edition, John Wiley & Sons Inc, 2012.

Course code	R5EL3106L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	INTRODUCTION TO MICROFABRICATION LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Simulate the process of Photo-lithography in CMOS fabrication and understand its impact on pattern transfer and device scaling.
2. Analyze and simulate oxidation processes in both dry and wet conditions to understand oxidation kinetics and its role in device insulation.
3. Model and simulate etching techniques (both dry and wet) and evaluate their effects on feature size and material selectivity.
4. Simulate the deposition processes used in CMOS fabrication, including Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD).
5. Implement diffusion processes and ion implantation techniques in CMOS fabrication, including junction depth and impurity profiles.

Sr.No.	Topics	
1	Implement the process of Photo-lithography in CMOS Fabrication.	
2	To simulate the Oxidation process in both dry and wet states.	
3	To simulate the process of Etching (Dry and Wet) in CMOS Fabrication.	
4	To simulate the Deposition process in CMOS Fabrication.	
5	To simulate the Diffusion process in CMOS Fabrication.	
6	To simulate the Ion Implantation process in CMOS Fabrication.	
7	To simulate the Annealing process in CMOS Fabrication.	
8	To simulate a MOS capacitor using a virtual fabrication process.	

Course code	R5EL3107T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	ERROR CORRECTING CODES						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply algebraic structures to construct Galois fields and cyclic codes.
2. Design and analyze error-correcting codes for reliable communication.
3. Implement compression and cryptographic coding for secure data transmission

Module	Content	Hrs
1	**Linear Abstract Algebra and Finite Fields** Groups, Fields, Rings, Vector spaces, subspaces, Galois field, Extension fields, Primitive element, primitive polynomial, GCD of polynomial, LCM of polynomial, minimal polynomial, cyclotomic cosets, factorization of (Xn-1) over a Galois field, construction of generator polynomial & parity check polynomial primitive nth root of unity.	8
2	**Linear Block Codes, Cyclic Codes** : Properties, Various methods of generation and detection of cyclic codes, error detecting capability, cyclic Hamming code	6
3	**BCH codes** Binary primitive BCH codes, decoding, iterative algorithm for finding the error location polynomial, error location numbers and error correction, implementation of error correction, primitive BCH codes, RS codes, decoding of BCH and RS codes.	8
4	**Convolutional Codes** Encoder and decoder, structural properties, optimum decoding of Convolutional codes, Viterbi, soft output Viterbi BCGR algorithm.	6
5	**Turbo codes and Low Density Parity Check Codes** Encoding, decoding scheme for Turbo code, Turbo code's application Encoding ,decoding scheme for LDPC , LDPC's application	6
6	**Compression Techniques and security coding techniques** Text compression, image compression and video compression techniques, Public key cryptography, coded based cryptosystem	8

Text Book:

1. K. Deergha Rao, *Channel Coding Techniques for Wireless Communications*, 2nd Edition, Springer, India, Private Ltd, 2016.
2. Shu Lin, Daniel J.Costello, *Error Control Coding,* 2nd, Edition, Pearson-prentice Hall, Reprint, 2012.

Reference:

1. G.Kabatiansky,E.Krouk,S.Semenov, *Error Control Coding and security for data network, Analysis of super channel concept* , John Wiley & Sons Ltd., 2005.
2. W. C. Huffman & Vera Pless, *Fundamentals of Error-Correcting Code* , Cambridge University Press; 1st edition (18 February 2010).
3. Stephen B. Wicker, *Error control systems for Digital communication & storage* , Prentice Hall,1995.
4. Ze-Nian Li,Mark S Drew and Jiangchuan Liu , *Fundamentals of Multimedia Video Compression* ,2nd Edition,Springer ,2014.
5. Richard E. Blahut, Th*eory and Practice of Error Control Codes* , Addison, Wesley Longman Publishing Co, 1983.

Course code	R5ET3107L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	ERROR CORRECTING CODES LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement the construction of GF(2^m), conjugacy classes, and minimal polynomials.
2. Develop and apply linear block, cyclic, convolutional, and Hamming codes for encoding and decoding.
3. Identify error detection and correction using specified generator polynomials and trellis structures.

Sr.No.	Topics	
1	Construction of GF(2^m)	
2	Construction of Conjugacy Classes	
3	Construction of Minimal Polynomials	
4	Encoding and Decoding using linear Block code	
5	Implementation of Cyclic Code	
6	Perform Convolutional encoding and decoding on a message sequence using the specified generator polynomial and trellis structure	
7	Implementation of Hamming Encoder and Decoder	
8	Implementation of Turbo Code Encoder and Decoder	

Course code	R5EL3108T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	ADVANCED DIGITAL SIGNAL PROCESSING						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply concept of linear algebra and Eigen analysis
2. Design and implement ARMA, AR and MA processes.
3. Apply MRA concepts.
4. Design wavelet based MRA for 1D 2D processing.

Module	Content	Hrs
1	**Multirate Digital Signal Processing** Decimation Interpolation Filter design and implementation Sampling rate conversion Application of multirate signal processing	7
2	**Review of Linear Algebra** Linear Algebra-Research part, abstractness, real life examples, Introduction to Random processes, numerical approach.	6
3	**Filtering Discrete Time random processes** Spectral Estimation, Levinson Durbin, evolution of Tukey, MUSIC..	7
4	**Spectral Factorization** Minimum phase signals & systems Partial energy & minimum delay Minimum phase & minimum delay property Spectral factorization theorem.	8
5	**Spectral Estimation by Classical methods** The periodogram The modified periodogram Barlett, Welch & BlackmanTuckey, approach	6
6	**Multiresolution Analysis using Wavelets** Introduction to time frequency analysis Short-time Fourier transform WignerVille transform Continuous time wavelet transform Discrete wavelet transform Tiling of the time-frequency plane and wavepacket analysis, Construction of wavelets, orthogonal, biorthogonal basis	8

Text Book:

1. S.M. Kay, *Modern Spectral Estimation*, Prentice hall, 1988.
2. J. G. Proakis, D.G. Manolakis, and D. Sharma, *Digital Time Signal Processing: principles, algorithms, and applications*, Pearson Education, 2006.
3. DaFatta, D. J., Lucas, J. G., and Hodgkiss, W. S*,Digital Signal Processing: A system design approach*, Wiley publications, 1988.

Reference:

1. R. M. Rao, and A.S. Bopardikar, *Wavelet Transforms*, Pearson Education, 2001.
2. C. S. Burrus, R. A. Gopinath, and H. Guo,. *Introduction to Wavelets and Wavelets Transforms*, PrenticeHall, 1998.
3. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, 1993.

Course code	R5EL3108L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	ADVANCED DIGITAL SIGNAL PROCESSING LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply and implement the concept of linear algebra and Eigen analysis.
2. Implement ARMA, AR and MA processes.
3. Apply MRA concepts.
4. Implement wavelet based MRA for speech and image signals.

Lab Instructions: At least 1-2 experiments should be conducted on each topic

Sr.No.	Topics	
1	**Multirate Digital Signal Processing:** Multirate sampling	
2	**Spectral Filtering** 2.1 Auto Regressive process 2.2 Moving average process 2.3 ARMA process	
3	**Filtering Discrete Time random processes** 3.1 Levinson Durbin, 3.2 Schur algorithm 3.3 Tukey algorithm 3.4 MUSIC algorithm	
4	**Spectral Estimation** Design and implementation of periodogram method, modified periodogram, Barlett, Welch & Blackman-Tuckey algorithms approach.	
5	**Multiresolution Analysis using Wavelets** MRA using filter banks	

Text Book:

1. S.M. Kay, *Modern Spectral Estimation*, Prentice hall, 1988.
2. J. G. Proakis, D.G. Manolakis, and D. Sharma, *Digital Time Signal Processing: principles, algorithms, and applications*, Pearson Education, 2006.

Reference:

1. R. M. Rao, and A.S. Bopardikar, *Introduction to Wavelets and Wavelets Transforms* ,Wiley publications , 1988.
2. C. S. Burrus, R. A. Gopinath, and H. Guo, *Introduction to Wavelets and Wavelets Transforms,* PrenticeHall, 1998.
3. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, 1993

Course code	R5EL3109T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	DATA SCIENCE						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Utilize sophisticated mathematical, statistical, and machine learning methods to extract meaningful insights and build predictive models from complex datasets.
2. Design and implement efficient data acquisition, cleaning, transformation, and storage processes using industry-standard tools and programming languages.
3. Articulate complex data findings and recommendations clearly and persuasively to both technical and non-technical audiences through compelling visualizations and narratives.
4. Analyze data science problems from diverse domains, select appropriate methodologies, and develop ethical and impactful solutions.

Module	Content	Hrs
1	**Foundational Mathematics and Statistics:** Linear Algebra: Vectors, matrices, matrix operations, systems of linear equations, eigenvalues and eigenvectors, dimensionality reduction techniques (e.g., Principal Component Analysis – PCA) Calculus: Differentiation, integration, optimization techniques (e.g., gradient descent). Probability and Statistics: Descriptive statistics: Measures of central tendency, dispersion, and shape. Probability theory: Basic concepts, conditional probability, Bayes' theorem. Probability distributions: Discrete (e.g., binomial, Poisson) and continuous (e.g., normal, exponential) distributions. Inferential statistics: Hypothesis testing, confidence intervals, p-values. Statistical modeling: Linear regression, logistic regression, analysis of variance (ANOVA)	9
2	**Programming and Data Handling** Programming Languages: Python: Fundamentals, data structures (lists, dictionaries, etc.), libraries for data manipulation (Pandas), numerical computation (NumPy), and visualization (Matplotlib, Seaborn). R: Fundamentals, data structures, statistical analysis capabilities, and visualization libraries. Database Management Systems: Relational databases (SQL): Database design, querying, data manipulation. NoSQL databases: Understanding different types (e.g., document, key-value) and their applications. Data Wrangling and Pre-processing: Data cleaning, Data transformation, Data integration.	9
3	**Core Data Science Concepts and Techniques** Exploratory Data Analysis (EDA): Techniques for visualizing and summarizing data to gain insights. Machine Learning: Supervised learning: Classification (e.g., decision trees, support vector machines, naive Bayes), regression (e.g., linear regression, polynomial regression). Unsupervised learning: Clustering (e.g., k-means, hierarchical clustering), dimensionality reduction (e.g., PCA, t-SNE), association rule mining.	10

	Model evaluation and selection: Metrics for classification and regression, cross-validation, hyperparameter tuning. Deep Learning: Neural networks: Fundamentals, activation functions, backpropagation. Convolutional Neural Networks (CNNs): Image recognition and processing. Recurrent Neural Networks (RNNs): Sequence data analysis (e.g., time series, natural language). Big Data Technologies: Distributed computing frameworks (e.g., Hadoop, Spark). Cloud computing platforms for data science (e.g., AWS, Azure and GCP). Data Visualization: Principles of effective data visualization, using tools and libraries to create informative charts and graphs (e.g., Tableau, Power BI, Python libraries).	
4	**Cutting-Edge Data Science Techniques** Natural Language Processing (NLP): Text analysis, sentiment analysis, topic modeling, language modeling. Computer Vision: Image analysis, object detection, image segmentation. Time Series Analysis: Forecasting, modeling time-dependent data. Big Data Analytics: Advanced techniques for analyzing large and complex datasets. Cloud Computing for Data Science: Utilizing cloud services for data storage, processing, and machine learning. Data Mining: Knowledge discovery from large datasets. Business Intelligence: Using data analysis to support business decision-making. Data Ethics and Privacy: Understanding ethical considerations and legal frameworks related to data collection and use. Domain-Specific Applications: Applying data science techniques to specific fields (e.g., healthcare, finance, marketing, environmental science).	8
5	**Research and Project Work** Research Methodology: Principles of scientific research, formulating research questions, designing experiments. Data Science Project: A significant hands-on project where students apply their knowledge and skills to solve a real-world problem. This often includes data collection, cleaning, analysis, modeling, and presentation of results.	6

Text Book:

1. Guttag, John. *Introduction to Computation and Programming UsinG Python: With Application to Understanding Data*. 2nd ed. MIT Press, 2016. ISBN: 9780262529624.
2. Gelman, Andrew, et al. *Bayesian Data Analysis*. 2nd ed. Chapman and Hall/CRC, 2003. ISBN: 9781584883883.

Reference:

1. Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. The Elements of Statistical Learning: Data Mining, *Inference, and Prediction: with 200 full-color illustrations*. New York, NY: Springer, c2001. ISBN:0387952845.
2. Duda, Richard O., Peter E. Hart, and David G. Stork. *Pattern Classification*. New York, NY: John Wiley & Sons, 2000. ISBN: 9780471056690.
3. “Deep learning” by goodfellow, bengio and courville.
4. “Hands on Machine learning with scikit -learn, Keras & Tensor flow” by Aureleien Geron

Course code	R5EL3109L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	DATA SCIENCE LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Process and transform raw data into suitable formats
2. Implement Bayesian techniques for data analysis
3. Implement regularization techniques with interpretation
4. Implement clustering methods
5. Implement Monte Carlo simulation

Sr.No.	Topics	
1	Fundamentals of Python programming for data science	
2	Implement data visualization and wrangling (ggplot)	
3	Implement linear regression with different regularization techniques	
4	Implement Bayesian classifier with different densities	
5	Implement SVM classifier with feature kernel techniques	
6	Implement clustering using different methods	
7	Implement monte carlo simulation for complex problems	
8	Implement Machine learning algorithm on a distributed computing frameworks.	
9	Implement Machine learning algorithm on Cloud computing platforms.	

Course code	R5EL3106L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	INTRODUCTION TO MICROFABRICATION LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

6. Simulate the process of Photo-lithography in CMOS fabrication and understand its impact on pattern transfer and device scaling.
7. Analyze and simulate oxidation processes in both dry and wet conditions to understand oxidation kinetics and its role in device insulation.
8. Model and simulate etching techniques (both dry and wet) and evaluate their effects on feature size and material selectivity.
9. Simulate the deposition processes used in CMOS fabrication, including Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD).
10. Implement diffusion processes and ion implantation techniques in CMOS fabrication, including junction depth and impurity profiles.

Sr.No.	Topics	
1	Implement the process of Photo-lithography in CMOS Fabrication.	
2	To simulate the Oxidation process in both dry and wet states.	
3	To simulate the process of Etching (Dry and Wet) in CMOS Fabrication.	
4	To simulate the Deposition process in CMOS Fabrication.	
5	To simulate the Diffusion process in CMOS Fabrication.	
6	To simulate the Ion Implantation process in CMOS Fabrication.	
7	To simulate the Annealing process in CMOS Fabrication.	
8	To simulate a MOS capacitor using a virtual fabrication process.	

MDM-IV: Minor in Electronics & Communication

Course code	R5ET3204T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	DATA COMMUNICATION						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concept . Fundamentals of Data Communication and Computer Network.
2. Implement the concept of Transmission Media And Switching:
3. Define terminology of data communications and Apply various network layer Techniques to analyze packet flow on the basis of routing protocols.
4. Identify error detection and correction using appropriate techniques.

Module	Content	Hrs
1	**Fundamentals of Data Communication and Computer Network:** Process of data communication and its components: Transmitter, Receiver, Medium, Message, Protocol,Protocols, Standards, Standard organizations, Bandwidth, Data Transmission Rate, Baud Rate and Bits per second ,Modes of Communication Analog and Digital Transmission: Analog To Digital, Digital To Analog Conversion ,Fundamental Of Computer Network: Definition And Need Of Computer Network, Applications, Network Benefits ,Classification Of Network: LAN, WAN,MAN	11
2	**Transmission Media And Switching:** Communication Media: Guided Transmission Media Twisted-Pair Cable, Coaxial Cable, Fiber-Optic Cable ,Unguided Trnsmission Media: Radio Waves, Microwaves, Infrared, Satellite Line-of-Sight Transmission, Point-to-Point, Broadcast ,Multiplexing: Frequency-Division Multiplexing ,Time - Division Multiplexing ,Switching: Circuit-switched network, Packet switched network	10
3	**Network layer protocol –** internetworking,IPv4, IPv4 protocol packet format, IPv6 Protocol & Packet format, IPv4 VS IPv6, Transition from IPv4 to IPv6,Address Resolution protocols (ARP, RARP), BOOTP, DHCP, Routing Protocols – Delivery, forwarding, routing, types of routing, routing tables, Unicast Routing, Unicast Routing protocols, RIP, Concepts of OSPF, BGP & Multicast Routing Transport Layer – Process to process delivery, UCP, TCP Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control (Open Loop, Closed Loop & Congestion control in TCP), QoS and Flow Characteristics Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP	12
4	**Error Control Coding :** Introduction to Error Control Coding, Need of Error control coding, Basic codes definitions , Error Detection, Parity, Checksum for error detection , Linear block codes, Matrix description of Linear Block codes, Parity check matrix, Decoding of Linear block codes , CRC	9

Text Book:

1. Behrouz A. Forouzan, “Data Communications and Networking” 4th Edition, McGraw-Hill, 2006.
2. Willam Stallings, “Data and Computer Communications”,8th Edition, Pearson, 2007

Reference:

1. W. Couch II, “Digital and Analog Communication Systems”, 6th Edition, Pearson Education Asia, 2002

2. Taub Schilling, “Principles of Communication Systems”, 2nd Edition, Tata McGraw Hill, 2004
3. John J Proakis, “Digital Communications”, 3rd Edition, McGraw-Hill Higher Education, 2001
4. A.S.Tanenbaum,”Computer Networks”,4th edition,Pearson education,2002.

MDM-IV:Minor in Cyber Security

Course code	R5ET3203T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	IOT AND CLOUD SECURITY						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Describe basic concepts of IoT and Cloud Security.
2. Assess different Internet of Things technologies and their applications.
3. Implement basic concepts of Internet of Things Security in real-world scenarios .
4. Identify areas of cybersecurity for cloud security.

Module	Content	Hrs
1	**Fundamentals of IoT and Cloud Security :** Architectural and Technological Components, Principals of IoT Security Basic Types: IaaS, PaaS, SaaS Cloud Design Principles: Hardening, Encryption, Layered Defence. **Introduction to Cloud Platform**: AWS, Design Secure Solutions with AWS, Introduction to IoT Architectures and APIs Constraints and challenges in IoT Design. Concept of AWS SDK Package	5
2	**Vulnerabilities, Attacks and Risks in IoT and Cloud Security:** IoT and Cloud Attack Surface , Shared Cloud Platform Risks and Responsibilities Cloud Security Risks: IaaS, PaaS, and SaaS IoT Security Risks	5
3	**TRUST MODELS FOR IOT:**Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things	10
4	**Internet of Things Security :**Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security-IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links inIoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs, Commercialized Products	10
5	**Cloud Security for IOT Cloud services and IoT:** Offerings related to IoT from cloud service providers, Cloud IoT security controls, An enterprise IoT cloud security architecture, and New directions in cloud enabled IoT computing.	06
6	**IoT Pen testing**	06

	Active vulnerability analysis tools, Port scanning, Operating system fingerprinting and version scanning, Penetration testing, Attack surface mapping **Exploitation Tools & Frameworks:** Exploitation using I2C & SPI, JTAG,, debugging and exploitation, Boundaryscan, Test access ports	

Text Books:

1. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition,CRC Press, 2016.
2. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1st edition, Packt Publishing Ltd, 2016.
3. Shancang Li, Li Da Xu Securing the Internet of Things , ,Syngress,Elsevier, 2017

References:

1. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of Things devices and beyond, 1st edition, NCC Group, 2014
2. DaCosta, Francis, and Byron Henderson. Rethinking the Internet of Things: a scalable approach to connecting everything, 1st edition, Springer Nature, 2013

Exit Course

Course code	R5ET3901T	Semester	-	Credits	2	Scheme	3L:0T:0P
Course	BASICS OF MOBILE COMMUNICATION						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe different types of mobile services and systems.
2. Describe the basic concepts of Cellular Systems and multiple access techniques in cellular mobile communication.
3. Elaborate on the various propagation effects and propagation models used in mobile communication
4. Describe various methodologies to improve the received signal quality in mobile communication.

Module	Content	Hrs
1	**Introduction to Wireless Mobile Communication** History and evolution of mobile radio systems, Types of mobile wireless services/systems – Cellular, WLL, Paging, Satellite systems, Standard, Future trends in personal wireless systems.	6
2	**Multiple Access Techniques** Multiple Access Techniques – FDMA, TDMA and CDMA systems, Operational systems, Wireless networking, design issues in personal wireless systems.	5
3	**Cellular Concept And System Design Fundamentals** Cellular concept and frequency reuse, Multiple Access Schemes, Channel assignment and handoff, Interface and system capacity, Trunking and Erlang capacity calculations.	5
4	**Mobile Radio Propagation** Radio wave propagation issues in personal wireless systems, Propagation models, Multipath fading and based and impulse models, Parameters of mobile multipath channels, Antenna systems in mobile radio	6
5	**Introduction To 2G And 3G** GSM Network Architecture,GSM channels, GSM services and features,GSM Call procedures, Authentication and security in GSM, CDMA:CDMA Architecture,CDMA channels,Handoff and Power Control,WCDMA System,CDMA 2000 Cellular Technologies	6

Text Book:

1. Rappaport,T.S., Wireless communications , 2nd Edition, Pearson Education,2010
2. Vijay Garg , Wireless Communications and networking , 1st Edition, 2007

Reference:

1. Young Kyun Kim and Ramjee Prasad, 4 G Roadmap and Emerging Communication
2. Technologies , 3rd Edition ,Artech house.2006.
3. Raj Pandya, Mobile And Personal Communications Systems And Services , Prentice hall,3rd Edition , 2000.

Course code	R5ET3901L	Semester	-	Credits	1	Scheme	0L:0T:2P
Course	BASICS OF MOBILE COMMUNICATION LAB						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concept of frequency reuse in cellular communication systems.
2. Describe different parameters for the propagation model.
3. Analyze different parameters of antenna used in mobile communication.
4. Describe the concept of interleaving in GSM and CDMA.

LIST OF TOPICS FOR BASICS OF MOBILE COMMUNICATION LAB

Sr.No.	Topics	
1	To Simulate different multiple Access techniques using NETSIM.	
2	To find co-channel cells for particular cell by using cellular frequency reuse concept.	
3	To simulate free space propagation model with the help of matlab.	
4	To simulate okumura propagation model with the help of matlab.	
5	To simulate a HATA propagation model with the help of matlab.	
6	To simulate different antenna parameters for mobile communication**.**	
7	To simulate the various component of GSM Kit and Describe RF Module.	
8	To simulate interleaving in GSM.	
9	To simulate rake receiver in CDMA.	

Course code	R5ET3902T	Semester	-	Credits	2	Scheme	3L:0T:0P
Course	BASICS OF ANTENNAS						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Elaborate basic parameters of antennas.
2. Select antennas as per their operating frequency ranges and radiation patterns for a specific application.
3. Apply design principles to design an antenna.

Module	Content	Hrs
1	**Basic antenna concepts:** Definition and functions of an antenna, comparison between an antenna & transmission line, radio communication link with transmitting antenna and a receiving antenna, radiation patterns of antennas-field and power patterns, all antenna types.	4
2	**Antenna parameters and definitions:** beam area, beam width- Half-Power Beam width (HPBW)and First Null Beam width(FNBW) ,Polarisation, Radiation Intensity ,Beam Efficiency, Directivity and directive gain, radiation resistance, radiation efficiency, resolution, Antenna 5 10% aperture-physical and effective apertures, effective height, transmission formula, antenna field zones, Transmission loss as a function of frequency. Antenna temperature and signal to noise ratio.	6
3	**Radiation of Electric dipole:** Radiation from quarter wave monopole and half wave dipoles, Derivation for radiation resistance, application of reciprocity theorem to antennas**,** directional properties of dipole antennas, antenna feeding methods. **Arrays of dipoles & apertures:** 3 element dipole Array with parasitic elements, Yagi-Uda array-function and its design,end fire antenna, broadside array.	6
4	**Microstrip (patch) Antennas** Rectangular and circular types, function, feeding mechanism, features analysis, design considerations and applications of broadband antennas **Frequency Independent Antennas** Introduction, Log Periodic, Helical Antennas, Spiral antenna. Horn Antennas. Introduction, E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn, Conical Horn, Corrugated Horn.	5
5	**Reflector Antennas and Lens Antennas** Plane Reflector, Corner Reflector, Parabolic Reflector, feeding methods, Non-metallic dielectric and artificial dielectric lens antennas, reflector lens antennas.	4

Text Book:

1. John D. Cross, *Antennas* , Tata Mc Graw Hill Publications,2011.
2. C. A. Balani, *Antenna Theory Design & Analysis* , John Wiley & sons Publications, 2012.
3. G. S. N. Raju, *Antennas and Wave Propagation* , Pearson Education India,2006.

Reference:

1. Jordan, Balmain, *Electromagnetics Waves and Radiating Systems* , 2nd edition, PHI publications, .
2. A.R.Harish, M.Sachidananda, *Antennas and Wave propagation* , Oxford University Press, 1st Edition, 2007.
3. K.D. Prasad, Handa, Deepak, *Antenna and Wave propagations* , New Delhi: Satya Prakashan,3rd edition, 2003

Course code	R5ET3902L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	BASICS OF ANTENNAS LAB						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Test various Antennas performance.
2. Plot the radiation pattern and calculate various parameters.
3. Design a micro strip antenna to the given specification
4. Simulation and analyse the design.

LIST OF TOPICS FOR BASICS OF ANTENNA LAB

Sr.No.	Topics	
1	Plot the radiation pattern of half wave dipole and find HPBW.	
2	Check the radiation pattern of rhombic antenna.	
3	Plot radiation pattern of loop antenna and calculate its parameters.	
4	Plot radiation pattern of folded dipole antenna.	
5	Test the performance of the Log -periodic antenna.	
6	Plot radiation pattern of the broad side array antenna and calculate its parameters.	
7	Plot radiation pattern of the end fire array antenna and calculate its parameters.	
8	Check the radiation pattern of the parabolic reflector antenna.	
9	Test the performance of the horn antenna.	
10	Design Microstrip Patch antenna using simulation software.	

Text Book:

1. John D. Cross, Antennas , Tata Mc Graw Hill Publications. 2011.
2. C. A. Balani, Antenna Theory Design & Analysis , John Wiley & sons Publications. 2012
3. G. S. N. Raju, ―Antennas and Wave Propagation , Pearson Education India. 2006.