KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

UDYAMBAG, BELAGAVI-590008

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)

(APPROVED BY AICTE, NEW DELHI)

Department of Electronics and Communication Engineering

2018-2019

Scheme and Syllabus

M. Tech. (Digital Communication and Networking)

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION

To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem-solving ability with an analytical and innovative mindset.

QUALITY POLICY

- Imparting value added technical education with state-of-the-art technology in a congenial, disciplined and a research-oriented environment.
- Fostering cultural, ethical, moral and social values in the human resources of the institution.
- Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

DEPARTMENT VISION

The Electronics & Communication Engineering department shall impart quality technical education and entrepreneurship skills to develop creative individuals to face changing global scenario.

MISSION

To augment the national talent pool, with Electronics and Communication Engineers having all-encompassing technical knowledge, principled practices and nationalistic outlook.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. The graduates will acquire core competence in basic science and Digital Communication and Networking fundamentals necessary to formulate, analyze, and solve engineering problems and to pursue advanced study or research.
2. The graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth and self-confidence to adapt to rapid and major changes.
3. The graduates will maintain high professionalism and ethical standards, effective oral and written communication skills, work as part of teams on multidisciplinary projects under diverse professional environments, and relate engineering issues to the society, global economy and to emerging technologies.

PROGRAM OUTCOMES (POs)

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, 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 specified needs with appropriate consideration for public health and safety, 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 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 modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of 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 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 lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Understanding and applying the mathematical and scientific concepts, for analysis and design of basic Electronics and Communication systems.
2. Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.
3. Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.

Scheme of Teaching
Semester I

S. No.	Course Code	Course		Contact Hours	Contact Hours/week	Total credits	Marks		
				L – T - P			CIE	SEE	TOTAL
1.	18DCN11	Applied Engineering Mathematics	PC1	4 – 0 – 0	4	4	50	50	100
2.	18DCN12	Advanced Digital Communication	PC2	4 – 0 – 0	4	4	50	50	100
3.	18DCN13	Advanced Computer Networks	PC3	4 – 0 – 0	4	4	50	50	100
4.	18DCN14X	Elective – I	PE- I	4 – 0 – 0	4	4	50	50	100
5.	18DCN15	Lab – 1: Advanced Communication Lab	L1	0 – 0 – 3	3	1.5	25	25	50
6.	18DCN16	Lab – 2: Advanced Networking Lab	L2	0 – 0 – 3	3	1.5	25	25	50
7.	18DCN17	Seminar		0 – 0 – 1	1	2	25	-	25
		Total		**16 – 0 – 7**	**23**	**21**	**275**	**250**	**525**

SEE: SEE (Theory exam) will be conducted for 100marks of 3 hours duration. It is reduced to 50 marks for the calculation of SGPA and CGPA
Term Assignment: The performance is continuously evaluated by the faculty member and Grade is given.

Elective – I: List of subjects

Subject Code	Subjects
18DCN141	Advances in Antenna and Microwave Engineering
18DCN142	Information Security
18DCN143	Remote Sensing and GIS
18DCN144	Machine Learning Algorithms

Semester II

S. No.	Course Code	Course		Contact Hours	Contact Hours/ week	Total credits	Marks		
				L – T – P			CIE	SEE	TOTAL
1.	18DCN21	Cloud Computing	PC1	4 – 0 – 0	4	4	50	50	100
2.	18DCN22	Applied DSP	PC2	4 – 0 – 0	4	4	50	50	100
3.	18DCN23X	Elective-II	PE- II	4 – 0 – 0	4	4	50	50	100
4.	18DCN24	Research Methodology and IPR	HS	4 – 0 – 0	4	4	50	50	100
5.	18DCN25	Lab – 1: Cloud Computing Lab	L1	0 – 0 – 3	3	1.5	25	25	50
6.	18DCN26	Lab – 2: Applied DSP Lab	L2	0 – 0 – 3	3	1.5	25	25	50
7.	18DCN27	Mini Project with seminar	PC	0 – 0 – 1	1	2	25	-	25
		Total		**16 – 0 – 7**	**23**	**21**	**275**	**250**	**525**

*** SEE: SEE (Theory exam) will be conducted for 100marks of 2hours/ 3 hours duration. It is reduced to 50 marks for the calculation of SGPA and CGPA**

Mini project: The performance is continuously evaluated by the faculty member and Grade is given.

Elective – II: List of subjects

Subject Code	Subjects
18DCN231	Pattern Recognition and Classification
18DCN232	Optical Networks
18DCN233	Cyber Physical Systems
18DCN234	Ad-hoc Networks

Semester III

S. No.	Course Code	Course		Contact Hours	Contact Hours/ week	Total credits	Marks		
				L – T – P			CIE	SEE	TOTAL
1.	18DCN31	#Internship				14	50	50	100
2.	18DCN32	*Project Phase – 1	PR			4	50	-	50
		Total				**18**	**100**	**50**	**150**

#Internship:

Duration:16 – 24 weeks,

Progress Presentation: 1st:- After 8 weeks from the commencement of III Semester (CIE-50 marks)

2nd:- After completion of internship (CIE-50 marks)

Project Phase- 1: Selection of topic, Literature Review, Problem formulation and submission of synopsis

Semester IV

S. No.	Course Code	Course		Contact Hours	Contact Hours/ week	Total credits	Marks		
				L – T – P			CIE	SEE	Total
1.	18DCN41	Error Control Coding	PC1	4 – 0 – 0	4	4	50	50	100
2.	18DCN42X	Elective – III	PE – III	4 – 0 – 0	4	4	50	50	100
3.	18DCN43	Project Phase – 2	PR	0 – 0 – 2	2	4	50(25+25)	--	50
4.	18DCN44	Project Phase – 3	PR	0 – 0 – 2	2	4	50(25+25)	--	50
5.	18DCN45	Publication based on project	PR	0 – 0 – 0	1	2	25		25
6.	18DCN46	Evaluation of Project and Viva – voce	PR	0 – 0 – 0	--	10	--	150(50+100)	150
		Total		**8 – 0 – 4**	**13**	**28**	**225**	**250**	**475**

Elective – III: List of subjects

Elective – III	
18DCN421	High-Performance Computing
18DCN422	Human-Computer Interaction
18DCN423	CMOS RF Circuit Design
18DCN424	Real Time Systems

Project Phase 2: CIE – 50 marks (25 marks –Internal guide + 25 marks- presentation)
Project Phase 3: CIE – 50 marks (25 marks –Internal guide + 25 marks- presentation)
Project Viva-voce: SEE – 150 marks (50 marks for report evaluation (**Avg. of Internal & external examiner marks**) + 100 marks viva – voce)
Publication: Grades will be given based on publication in the type of Journal/Conference.

Applied Engineering Mathematics

Course Code	18DCN11	**Credits**	4
Course type	PC1	**CIE Marks**	50
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	100
Total Hours:	45	**SEE Duration**	3 Hours

Course Learning Objectives (CLOs)

1. To explore the basic concepts of linear algebra.
2. To study the orthogonal spaces and quadratic forms.
3. To learn the basic theorems related to Probability.
4. Evaluate and analyze various parameters of random variables.
5. To introduce probabilistic models for random processes.

Unit – I 9 Hours

Introduction to Linear Algebra:

Linear equations: Fields; system of linear equations, and its solution sets; elementary row operations and echelon forms; matrix operations; invertible matrices, LU-factorization. Vector spaces: Vector spaces; subspaces; bases and dimension; coordinates; computations concerning subspaces.

Linear Transformations: Algebra of linear transformations; isomorphism; representation of transformations by matrices; linear functionals.

Self-learning topic: transpose of a linear transformation

Unit – II 9 Hours

Inner Product Spaces, Symmetric Matrices and Quadratic Forms:

Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process.

Symmetric Matrices and Quadratic Forms: Digitalization; quadratic forms; singular value decomposition.

Unit – III 9 Hours

Introduction to Probability theory and Random variables:

Experiments, Sample space, Events, Axioms, Assigning probabilities, Joint and conditional, Baye's theorem, Independence, Discrete random variables. Cumulative distribution function (CDF), Probability density function (PDF), PDF and CDF characterization of: Gaussian random variable, Uniform, Exponential, Laplace and Rayleigh types of random variables.

Unit – IV 9 Hours

Operation on a single random variable and pairs of random variables:

Expected value (EV), EV of random variables, EV of functions of random variables, Central moments, Conditional expected values, Characteristic functions, Joint PDF, Joint probability mass functions, Conditional distribution, Density and mass functions, EV involving pairs of random variables, Independent random variables, Complex random variables.

Self-learning topics: Probability generating functions, Moment generating functions.

Unit – V **9 Hours**

Multiple random variables and Random processes:

Joint and conditional PMF, CDF, PDF, EV involving multiple random variables, Gaussian random variable in multiple dimension, Random process: Definition and characterization, Stationarity and Ergodicity of random processes, Properties of ACF. Example Processes: Markov processes, Gaussian processes, Poisson processes.

Text Books

1. David C. Lay, "Linear Algebra and its Applications," 3rd edition, Pearson Education (Asia) Pvt. Ltd, 2005.
2. S. L. Miller and D. C. Childers, "Probability and Random Processes with Application to Signal Processing and Communication", Academic Press/ Elsevier 2004 and onwards

Reference Books

1. Gilbert Strang, "Linear Algebra and its Applications," 3rd edition, Thomson Learning Asia, 2003.
2. A. Papoullis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes", McGraw- Hill, 2002 and onwards.
3. Peyton Z. Peebles, "Probability, Random Variables and Random Signal Principles", 4th ed., TMH, 2007 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Apply the concept of linear equations and transforms to dynamic systems.	L3
2. Understand the properties of orthogonal spaces and quadratic form representation.	L2
3. Apply Bayes' theorem to estimate posterior probabilities.	L3
4. Illustrate various operations on random variables.	L3
5. Evaluate various probabilistic models based on random processes.	L5

Program Outcome of this course (POs)

	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentation
3. Videos
4. Notes

Assessment methods

1. IA test
2. Assignment
3. Seminar
4. Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two assignments / activity	Seminar/Mini project	Total Marks
Maximum Marks: 50	30	10	10	50

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass: 40**
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Advanced Digital Communication

Course Code	18DCN12	**Credits**	4
Course type	PC2	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand the generation, demodulation of coherent and non-coherent digital modulation techniques and wireless channels.
2. Study ISI, give solution to suppress ISI and exposure to channel equalization.
3. Study single and multiple error correction codes, spread spectrum techniques and matched filter concepts.
4. Study polynomial and turbo coding techniques.
5. Study OFDM and multicarrier modulation techniques.

Unit – I 9 Hours

Coherent and Non-Coherent Communication:

Coherent receivers, Optimum receivers in AWGN-IQ modulation & demodulation Non-coherent receivers in random phase channels; MFSK receivers-Rayleigh and Rician channels-Partially coherent receivers–DPSK; MPSK; M-DPSK-BER Performance analysis. Carrier Synchronization-Bit synchronization.

Unit – II 9 Hours

Equalization Techniques:

Band Limited Channels-ISI-Nyquist Criterion Controlled ISI-Partial Response signals-Equalization algorithms-Viterbi Algorithm-Linear equalizer-Decision feedback equalization-Adaptive Equalization algorithms.

Unit – III 9 Hours

Block Coded Digital Communication:

Architecture and performance–Binary block codes; Orthogonal; Biorthogonal; Trans orthogonal–Shannon's channel coding theorem; Channel capacity, Concepts of Spread spectrum communication–Coded BPSK and DPSK demodulators–Linear block codes; Hammning; Golay; Cyclic; BCH; Reed-Solomon codes – Space time block codes.

Unit – IV 9 Hours

Convolutional Coded Digital Communication:

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram. Decoding techniques using Maximum likelihood, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

Unit - V **9 Hours**

Orthogonal Frequency Division Multiplexing:

Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; OFDM signal processing; Peak Power Problem: PAP reduction schemes-Clipping, Filtering, Coding and Scrambling.

Text Books

1. Bernard Sklar, "Digital Communications", 2nd edition, Pearson Education, 2001.
2. John G. Proakis, "Digital Communication", 4th edition, Mc Graw Hill Publication, 2001.

Reference Books

1. Simon Haykin, "Digital communications", John Wiley and sons, 1998.
2. Shu Lin and Daniel J. Costello, "Error control coding", Pearson – Prentice Hall Publication, 2004.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Analyze various digital modulation techniques, the problems associated with each technique and methods to minimize the problems.	L4
2. Suggest techniques to minimize ISI and channel equalization methods.	L5
3. Design single and multiple error correction codes, matched filter to maximize SNR at the receiver.	L6
4. Design polynomial codes for error detection and correction.	L6
5. Analyze OFDM systems and suggest methods to maximize capacity and SNR.	L4

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentations

Assessment methods

1. IA test
2. Assignment
3. Seminar/Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Advanced Computer Networks

Course Code	18DCN13	**Credits**	4
Course type	PC3	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. To become familiar with the basics of Computer Networks.
2. To understand various Network packet switching techniques.
3. To study metrics of internetwork and routing.
4. Understand the Principles of Switches and Control Planes.
5. To understand the block chain technology.

Unit – I 9 Hours

Foundation: Building a Network, Requirements, Perspectives, Scalable Connectivity, Cost-Effective Resource sharing, network architecture, Protocol layering, Performance, Error detection, Reliable Transmission, Stop-and-Wait, Sliding Window, Concurrent Logical channels. Ethernet (802.3), wireless (802.11).

Unit – II 9 Hours

Internetworking: Switching and Forwarding, Datagram's, Virtual Circuit Switching, Source Routing, Basic Internetworking (IP), What is an Internetwork? Service Model, Global Addresses, Datagram Forwarding in IP, sub netting and classless addressing, Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Virtual Networks and Tunnels.

Unit – III 9 Hours

Network as a Graph: Distance Vector (RIP), Link State (OSPF), The Global Internet, Subnetting, Routing Areas, Routing among Autonomous systems (BGP).

End-to-End Protocols: Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), Segment Format, sliding window, Triggering Transmission, Adaptive Retransmission, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.

Unit –IV 9 Hours

Congestion Control and Resource Allocation: Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System DNS), Electronic Mail (SMTP, POP, IMAP, MIME), World Wide Web (HTTP).

Switches and Control Planes: Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs.

Unit – V 9 Hours

How SDN Works: Abstract, Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications.

Block chain Technology: Origin of block chain technology, The birth of block chain, Revolutionizing the Traditional Business Network, Exploring a block chain application, Recognizing the key business benefits, Building trust with block chain, What Makes a Block chain Suitable for Business, Identifying Participants and Their Roles, Use of Block chain in Internet of Things.

Text Books

1. Larry Peterson and Bruce S Davis, "Computer Networks: A System Approach" 5th Edition, Elsevier, 2014.
2. Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014, Print Book ISBN: 9780124166752, eBook ISBN: 9780124166844.
3. Manav Gupta, Blockchain For Dummies, IBM Limited Edition, John Wiley & Sons, Inc.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Design a network with appropriate protocols selected according to requirement.	L4
2. Identify and explain current technology trends for the implementation and deployment of wireless ad-hoc network routing.	L2, L3
3. Apply the concept of SDN (i.e. abstracting and centralizing the control plane).	L3
4. Identify the use of block chain technology	L1

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Blackboard Teaching
2. Presentation
3. Notes

Assessment methods

1. Assignments
2. Internal Assessment Tests
3. Seminar/Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective - I: Advances in Antenna and Microwave Engineering

Course Code	18DCN141	**Credits**	4
Course type	PE – I	**CIE Marks**	50 marks
Hours/week: L-T-P	4 –0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Define specifications for a communications system based on a set of requirements.
2. Design computer codes for moment method of moment analysis of wire antennas.
3. Design antenna numerical analysis method to analyze antennas.
4. Derive and understand properties of various microwave components (both passive and active), circuits, and learn how to apply these properties for particular designs.
5. Design basic RF/microwave frontend functional blocks using both analytical tools and advanced computer-aided design tools.

Unit – I 9 Hours

Linear Array Antenna:

N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, Design Procedure, N-Element Linear Array: Three-Dimensional Characteristics, Rectangular-to-Polar Graphical Solution, N-Element Linear Array: Uniform Spacing, Non-uniform Amplitude, Superdirectivity, Planar Array Design Considerations, Circular Array. (Textbook 1)

Passive Microwave Circuit Design Fundamentals:

Introduction, Smith chart and applications (Textbook 3)

Unit – II 9 Hours

Antenna Synthesis:

Formulation of the synthesis problem, synthesis principles, line sources shaped beam synthesis, linear array shaped beam synthesis — Fourier Series, Woodward — Lawson sampling method, comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods Dolph Chebyshev linear array, Taylor line source method. (Textbook 2)

Unit – III 9 Hours

Antenna Synthesis: Method of Moments: Introduction to method of Moments, Pocklington's integral equation, integral equations and Kirchoff's Networking Equations, Source Modeling Weighted residuals formulations and computational consideration, calculation of antenna and scatter characteristics. (Textbook 2)

Unit – IV 9 Hours

Matching Networks:

Design of matching networks, Definition of impedance matching, Matching using lumped and distributed elements.

Basic consideration in active networks: Stability consideration, gain consideration, Noise consideration. (Textbook 3)

Unit – V **9 Hours**

Design of amplifiers, oscillators and detector:

Linear and nonlinear design: Introduction, Types of amplifier, Design of different types of amplifiers, Multistage small signal amplifiers, Design of transistor oscillators, Detector losses, detector design. Study of RF amplifier design using Agilent Advanced Design System (ADS).

Text Books

1. C. A. Balanis, "Antenna Theory Analysis and Design", 3rd Edition, John Wiley, 2005 and onwards.
2. Stutzman and Thiele, "Antenna Theory and Design", 2nd Edition and onwards, John Wiley and Sons Inc.
3. Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education, Edition, 2004 and onwards.
4. Reinhold Ludwig, and Pavel Bretchko, "RF circuit design theory and applications", Pearson Education, edition, 2004 and onwards.

Reference Books

1. John D. Kraus, "Antennas", 3rd/4th Edition and onwards, McGraw Hill.
2. R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, "Microstrip Antenna Design Handbook", Norwood, MA: Artech House, 2001 and onwards.
3. D. Pozar, "Microwave Engineering", J. Wiley and Sons, 3rd Edition, 2004 and onwards.
4. K. Chang, I. Bahl, and V. Nair, "RF and Microwave Circuit and Component Design for Wireless Systems", J. Wiley & Sons, 2002 and onwards.
5. G. Gonzalez, "Microwave Transistor Amplifiers", 2nd Edition, Prentice Hall, 1997 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain the basic function of a given antenna based on the geometry and give a general description of the performance, e.g. the approximate shape of radiation pattern, bandwidth, and polarization.	L1
2. Design an antenna from a given specification and be able to judge, by using physical constraints, if it is possible to fulfill the goals of a specification.	L5
3. Use measurement equipment to measure antenna performance.	L4
4. Use numerical software to design and evaluate antennas.	L4
5. Design RF control, amplifier and mixer circuits by fabricating a microwave front end circuit using microwave components.	L5

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
4. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

5. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change. 12

Course delivery methods

1. Blackboard Teaching
2. Presentations

Assessment methods

1. Internal Assessment
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective - I: Information Security

Course Code	18DCN142	**Credits**	4
Course type	PE – I	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Explain the network security model.
2. Demonstrate use of various private and public key encryption techniques used in modern cryptosystems.
3. Explain the concept of digital signatures and authentication protocols.
4. Explain the concept of secured electronic transaction with web security considerations.
5. Analyze the security issues with Kerberos and E-mails.

Unit - I 9 Hours

Introduction on Security

Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability, Security services and mechanisms, Techniques: Cryptography, Steganography, Revision on Mathematics for Cryptography.

Case study: Any two watermarking techniques.

Unit – II 9 Hours

Symmetric & Asymmetric Key Algorithms

Substitutional Ciphers, Transposition Ciphers, Stream and Block Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, principle of asymmetric key algorithms, RSA Cryptosystem.

Case study: Elliptic curve cryptography.

Unit – III 9 Hours

Integrity, Authentication and Key Management

Message Integrity, Hash functions: SHA, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

Case study: Any two Biometric authentication techniques.

Unit – IV 9 Hours

Network Security, Firewalls and Web Security

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature.

Case study: VoIP security.

Unit – V **9 Hours**

Wireless Network Security

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for 4G networks: Secure Ad hoc Network, Secure Sensor Network.

Case study: Any two techniques for Ad hoc Network security.

Text Books

1. Behrouz A. Fourcuzan, "Cryptography and Network security" Tata McGraw- Hill, 2008 and onwards.
2. William Stallings, "Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India, New Delhi,2002 and onwards.
3. Atul Kahate, "Cryptography and Network security", 2nd Edition, Tata McGraw- Hill, 2008 and onwards.
4. R. K. Nichols and P.C. Lekkas, "Wireless Security".
5. H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, Feb. 2004.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Identify and describe different techniques in modern cryptography, in particular in private and public key cryptosystems.	L2
2. Analyze the techniques in the field of elliptic curve cryptography.	L4
3. Describe and motivate the fact that the implementation and development of modern communication technology requires security with reference to the data transmitted.	L2
4. Study the security issues related to internet and networks.	L2
5. Analyze the various techniques for securing the wireless networks.	L5

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective - I: Remote Sensing and GIS

Course Code	18DCN143	**Credits**	4
Course type	PE – I	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand the Remote Sensing and GIS.
2. Be aware of the classification and identification data using RS and GIS tools.
3. Build application of GIS.
4. Understand and develop to classify data using supervised and unsupervised classification.
5. Build application of GIS.

Unit – I **9 Hours**

Electromagnetic Radiation Theory and Spectral Signatures: Introduction and Basic Concepts of Remote Sensing Systems, The Digital Image.

Unit – II **9 Hours**

Radiometric Preprocessing and Atmospheric Correction: Geometric Image Correction, Spectral Image Enhancement - Operations in Spatial and Frequency Domain.

Unit - III **9 Hours**

Image Classification: Supervised and Unsupervised Classification, Accuracy Assessment, Artificial Intelligence, Object Oriented Classification.

Unit - IV **9 Hours**

Multispectral and Hyper-spectral Image: Analysis and Application in remote sensing.

Unit - V **9 Hours**

Geographic Information Systems (GIS): Integration of Remote Sensing and Geographic Information Systems (GIS), Urban Landscape Characterization and Analysis, Urban Feature Extraction, Applications of GIS.

Text Books

1. John R Jensen, "Remote Sensing of the Environment: An Earth Resource Perspective", 2nd Edn. (onwards), Prentice Hall, 2007.
2. Paul M. Mather, "Computer Processing of Remotely-Sensed Images: An Introduction", Wiley, 3rd Edn. (onwards), ISBN-13: 978-0470849194.
3. John R Jensen, **"**Introductory Digital Image processing", Prentice Hall, 3rd Edn. (onwards), 2004.

4. Qihao Weng, "Remote Sensing and GIS Integration Theories, Methods, and Applications" McGraw-Hill, ISBN: 978-0-07-160654-7.

Reference Books

1. Gary L. Prost and G. L. Prost, "Remote Sensing for Geoscientists: Image Analysis and Integration", Taylor & Francis,3rd Edn. (onwards), 2013.
2. John A. Richards and Xiuping Jia, "Remote Sensing Digital Image Analysis An Introduction", Springer, 4th Edn. (onwards), 2005.
3. Chen Ch, "Signal and Image Processing for Remote Sensing", Taylor & Francis, 2006 and onwards.
4. Liu, "Essential Image Processing and GIS For Remote Sensing", John Wiley and Sons, 2009 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Apply the design and development principles of Remote sensing and GIS.	L5
2. Design and implement application of RS and GIS in real time.	L6
3. Demonstrate the understanding of need for distributed systems and their applications.	L6
4. Analyze Multispectral and Hyper-Spectral Image in remote sensing applications.	L4
5. Analyse GIS and also able to integrate Remote Sensing and Geographic Information Systems (GIS).	L4

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective - I: Machine Learning Algorithms

Course Code	18DCN144	**Credits**	4
Course type	PE – I	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
2. Become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
3. Provide the mathematical background for carrying out the optimization associated with neural network learning.
4. Familiarize with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations.
5. Study Elementary Search Advanced Search Techniques.

Unit – I **9 Hours**

Introduction to Soft Computing: What Fuzzy, Artificial Neural Networks, Evolutionary Search Strategies.

Fuzzy Set Theory: Crisp, Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy Extension Principle.

Fuzzy Logic: Crisp, Fuzzy Logic Basics, Fuzzy Truth in Terms of Fuzzy Sets, Fuzzy Rules, Fuzzy Reasoning.

Unit – II **9 Hours**

Fuzzy Inference Systems: Introduction, Fuzzification of the Input Variables, Application of Fuzzy, Operators on the Antecedent Parts of the Rules, Evaluation of the Fuzzy Rules, Aggregation of Output Fuzzy Sets Across the Rules, Defuzzification of the Resultant Aggregate Fuzzy Set, Fuzzy Controllers.

Unit - III **9 Hours**

Artificial Neural Networks: Basic Concepts- Introduction, Computation in Terms of Patterns, The McCulloch–Pitts Neural Model, The Perceptron, Neural Network Architectures, Activation Functions, Learning by Neural Nets.

Unit - IV **9 Hours**

Pattern Classifiers: Ebb, Perceptrons, ADALINE, MADALINE.

Pattern Associators: Hopfield Networks, Bidirectional Associative Memory.

Competitive Neural Nets: Kohonen's Self-organizing Map (SOM), Learning Vector Quantization (LVQ), Adaptive Resonance Theory (ART).

Backpropagation: Multi-layer Feedforward Net, The Generalized Delta Rule, The Backpropagation Algorithm.

Unit - V **9 Hours**

Elementary Search Techniques: State Spaces, State Space Search, Exhaustive Search, Heuristic Search, Production Systems.

Strategies: Natural, Genetic Algorithms (GAs), Multi-objective Genetic Algorithms, Simulated Annealing.

Text Books

1. Samir Roy and Udit Chakraborty, "Introduction to Soft Computing- Neuro-Fuzzy and Genetic Algorithms", Pearson, 2013 and onwards.

Reference Books

1. J. S. R. Jang, C. T. Sun and E. Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004 and onwards.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997 and onwards.
3. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989 and onwards.
4. S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003 and onwards.
5. R. Eberhart, P. Simpson, and R. Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Identify and describe soft computing techniques and their roles in building intelligent machines.	L2
2. Recognize the feasibility of applying a soft computing methodology for a particular problem.	L2
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.	L5
4. Apply neural networks to pattern classification and other engineering problems.	L5
5. Apply genetic algorithms to combinatorial optimization problems.	L5
6. Effectively use existing software tools to solve real problems using a soft computing approach.	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis	4

and interpretation of data and synthesis of information to provide valid conclusions.

3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. 5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change. 12

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Lab: Advanced Communication Lab

Course Code	18DCN15	**Credits**	1.5
Course type	L1	**CIE Marks**	25 marks
Hours/week: L-T-P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	30	**SEE Duration**	3 Hours for 50 Marks

Course Learning Objectives (CLOs)

1. To enable the student, understand the various Basic Digital Modulation techniques and their Simulation.
2. To enable the student, understand advanced digital communication techniques and their Simulation.
3. To enable the student, understand the importance of variation in BER against SNR in digital communication techniques.
4. To compare the performance of different equalization techniques.
5. To study the importance of Least Mean Square algorithm.

List of Experiments

1. To study the effect of ISI in Amplitude Shift Keying using Signal Constellation and to analyze the effect of SNR variation on error probability.
2. To study the effect of ISI in Frequency Shift Keying using Signal Constellation and to analyze the effect of SNR variation on error probability.
3. To study the effect of ISI in Phase Shift Keying using Signal Constellation and to analyze the effect of SNR variation on error probability.
4. To study the effect of ISI in Quadrature Phase Shift Keying (QPSK) using Signal Constellation and to analyze the effect of SNR variation on error Probability.
5. To study the effect of BER against SNR for QPSK modulation in Rayleigh fading channel & AWGN channel.
6. To study the effect of BER against SNR for M-ary QAM with Rayleigh fading channel & AWGN channel.
7. To study the effect of BER against SNR for BPSK Modulation with ZFE Equalizer In 3 Tap ISI Channel.
8. To study the effect of BER against SNR for BPSK modulation with Minimum Mean Square Error (MMSE) equalization in 3 tap ISI channels.
9. Comparative analysis of BER for BPSK modulation in 3 tap ISI channels with ZFE and MMSE Equalization.
10. To study the performance of Least Mean Square (LMS) Algorithm.

Experiments 1, 2 3 and 4 shall be performed using Hardware and MATLAB
All Experiments shall be simulated using MATLAB

Text Books

1. Simon Haykin, "Digital communications", John Wiley and sons, 1998.
2. Bernard Sklar., "Digital Communications", 2nd edition, Pearson Education,2001.

3. John G. Proakis, "Digital Communication", 4th edition, Mc Graw Hill Publication, 2001.
4. Theodore Rappaport, 'Wireless Communications', 2nd edition, Pearson Education, 2002.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain basic digital modulation techniques.	L1
2. Discuss advanced digital modulation techniques and simulate.	L2
3. Apply the knowledge digital modulation techniques and analyze them.	L3
4. Explain the effect of BER in digital modulation.	L4
5. Compare the modulation techniques on the basis of BER.	L4

Program Outcome of this course (POs)	PO No.
1. **Fundamentals of Engineering**: Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Electronics and Communication Engineering.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Assessment methods

1. Internal Test
2. Activity
3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Lab test	Total Marks
Maximum Marks: 25	10	10	5	25
➢ **Minimum marks required to qualify for SEE:** 13				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.**

Initial write up	2*10 = 20 marks	
Conduct of experiments	2*10 = 20 marks	50 marks
Viva- voce	10 marks	

- **Submission and certification of lab journal is compulsory to qualify for SEE.**
- **Minimum marks required in SEE to pass: 20/50 (10/25)**
- **Viva-voce shall be conducted for individual student and not in a group.**

Lab: Advanced Networking Lab

Course Code	18DCN16	**Credits**	1.5
Course type	L2	**CIE Marks**	25 marks
Hours/week: L-T-P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	30	**SEE Duration**	3 Hours for 50 Marks

Course Learning Objectives (CLOs)

1. To enable the student, understand the various basic components Networking.
2. To enable the student, to understand and apply error detection & correction algorithms.
3. To enable the student, understand the importance of NS2 / NS3 simulator.
4. To enable the student to create nodes & establish communication.
5. To understand the creation of UDP & TCP agents.

List of Experiments:

1. Conduct the data link layer functions of Bit stuffing & Byte stuffing.
2. Compute the polynomial code checksum for CRC-CCITT.
3. Simulation of shortest path algorithm.
4. Creation of nodes & providing links between nodes.
5. Creation of TCP & UDP agents.
6. Creation of Trace files for the network.
7. Client & server program.
8. Implementation of distance vector routing algorithm.
9. Implementation of stop & wait protocol.
10. Implementation of data encryption & decryption of a given message.

Text Books

1. Alberto Leon Garcia and Indra Widjaja, "Communication Networks: Fundamental Concepts and Key Architectures", 3rd Edition, Tata McGraw- Hill, 2004.

2. Nader F. Mir, "Computer and Communication Networks", Pearson Education, 2007.

3. William Stallings, "Data and Computer Communication", 8th Edition, Pearson Education, 2007.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain importance of network topology.	L1
2. Implement different routing algorithms.	L3
3. Design and realize stop-wait protocols.	L6

4. Design and realize TCP & UDP agents. L6
5. Generate trace file for performance analysis. L2

Program Outcome of this course (POs)	PO No.
1. **Fundamentals of Engineering**: Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Electronics and Communication Engineering.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Assessment methods

1. Internal Test
2. Activity
3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Lab test	Total Marks
Maximum Marks: 25	10	10	5	25
➢ **Minimum marks required to qualify for SEE:** 13				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.**

Initial write up	2*10 = 20 marks	
Conduct of experiments	2*10 = 20 marks	50 marks
Viva- voce	10 marks	

- **Submission and certification of lab journal is compulsory to qualify for SEE.**
- **Minimum marks required in SEE to pass: 20/50 (10/25)**
  Viva-voce shall be conducted for individual student and not in a group.

Cloud Computing

Course Code	18DCN21	**Credits**	4
Course type	PC1	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Learn how to use Cloud Services.
2. Implement Virtualization.
3. Implement Task Scheduling algorithms.
4. Apply Map-Reduce concept to applications.
5. Build Private Cloud.

Unit – I 9Hours

Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.

Unit – II 9 Hours

Cloud Computing: Application Paradigms: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Grep The Web application , Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.

Unit – III 9 Hours

Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and para virtualization, Hardware support for virtualization, Case Study: Xen a VMM based para virtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization, Exercises and problems.

Unit – IV 9 Hours

Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed

virtual time, Cloud scheduling subject to deadlines, Scheduling Map Reduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems.

Unit –V **9 Hours**

Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis. Exercises and problems.

Text Books

1. Dan C Marinescu, "Cloud Computing Theory and Practice", Elsevier (MK),1st Edn. (onwards), 2013 and onwards.

Reference Books

1. Rajkumar Buyya, James Broberg and Andrzej Goscinski, "Cloud Computing Principles and Paradigms", Willey, 2ndEdn. (onwards), 2014 and onwards.
2. John W Rittinghouse and James F Ransome, "Cloud Computing Implementation, Management and Security", 1stEdn. (onwards), CRC Press 2013 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Demonstrate and experiment simple Cloud Applications and apply resource allocation, scheduling algorithms.	L5
2. Implement Map-Reduce concept.	L6
3. Create virtual machines from available physical resources.	L6
4. Setup a private cloud.	L5
5. Familiarize with Open Stack.	L2, L3

Program Outcome of this course (POs)	**PO No.**
1. **Fundamentals of Engineering:** Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Digital Communication and Networking.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern tool Usage:** Graduates shall possess critical thinking abilities, problem solving skills and familiarity with the necessary computational tools and procedures.	5

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentation
3. Video presentations

Assessment methods

1. IA test
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Applied Digital Signal Processing

Course Code	18DCN22	**Credits**	4
Course type	PC2	**CIE Marks**	50
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	100
Total Hours:	45	**SEE Duration**	3 Hours

Course Learning Objectives (CLOs)

1. To introduce the fundamentals of multirate systems.
2. To explore various filter bank structures.
3. To understand the perfect reconstruction in filter banks.
4. To introduce the synthesis of linear phase FIR QMF banks and efficient poly-phase structures.
5. To introduce the wavelet transform representation of signals.

Pre-requisites: Digital Signal Processing.

Unit – I 9 Hours

Fundamentals of Multirate Systems:
Basic multi-rate operations, interconnection of building blocks, poly-phase representation, multistage implementation, applications of multi-rate systems, special filters and filter banks (Text 1).

Unit – II 9 Hours

Maximally decimated filter banks:
Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks, M-channel filter banks, poly-phase representation, perfect reconstruction systems, alias-free filter banks, tree structured filter banks, trans-multiplexers (Text 1).

Unit – III 9 Hours

Para-unitary Perfect Reconstruction Filter Banks:
Lossless transfer matrices, filter bank properties induced by para-unitariness, two channel Para-unitary lattices, M-channel FIR Para-unitary QMF banks, transform coding (Text 1).

Unit – IV 9 Hours

Linear Phase Perfect Reconstruction QMF Banks:
Necessary conditions, lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF lattice (Text 1).

Cosine Modulated Filter Banks: Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems (Text 1).

Unit – V **9 Hours**

Wavelet Transform:

Short-time Fourier transform, Wavelet transform, discrete-time Ortho-normal wavelets, continuous time Ortho-normal wavelets (Text 2).

Text Books

1. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education (Asia) Pte.Ltd, 2004.
2. Gilbert Strang and Truong Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press,1996.

Reference Books

1. N. J. Fliege, "Multirate Digital Signal Processing", John Wiley & Sons, USA,2000.
2. Vikram Gadre and Aditya Abhyankar "Multiresolution and Multirate Signal Processing: Introduction, Principles and Applications", McGraw Hill Education, First edition (2017).
3. Steven M. Kay, "Modern Spectral Estimation", Pearson Education, First edition (2017)

Course Outcome (COs)

At the end of the course, the student will be able to:	Bloom's Level
1. Understand the fundamentals of multirate signal processing and its applications.	L1
2. Explain poly-phase representation and perfect reconstruction systems.	L2
3. Explain the properties of filter bank representation of signals and apply transform coding for efficient storage of signals.	L2, L3
4. Understand necessary conditions for linear phase perfect reconstruction and apply lattice structures for linear phase FIR PR QMF bank representation of signals.	L1, L3
5. Understand and explain the need of wavelet transform representation of signals.	L1, L2

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change. 12

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentation
3. Videos
4. Notes

Assessment methods

1. IA test
2. Assignment
3. Seminar
4. Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two assignments / activity	Mini project/ Seminar	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass: 40**
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – II: Pattern Recognition and Classification

Course Code	18DCN231	**Credits**	4
Course type	PE – II	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Provide knowledge of models, methods and tools used to solve regression, classification, feature selection and density estimation problems.
2. Provide knowledge of current research topics and issues in Pattern Recognition and Machine Learning.
3. Provide knowledge of learning and adaptation in supervised modes of learning.
4. Provide experience in conducting and presenting a literature review on a research topic.

Pre-requisites: It is assumed the students have a working knowledge of calculus, linear algebra, and probability theory. It is also assumed the students have some experience in programming in a scientific computing environment.

Unit - I **9 Hours**

Introduction to Pattern Recognition:

Introduction to Pattern Recognition - Definitions, Datasets for Pattern Recognition, Different Paradigms of Pattern Recognition., Tree Classifiers - Decision Trees: CART, C4.5, ID3, Random Forests, Bayesian Decision Theory.

Unit - II **9 Hours**

Parameter Estimation Methods:

Maximum Likelihood Estimation (MLE), Maximum *A Posteriori* Estimation (MAP), Bayes Estimator for multivariate Gaussian density with unknown covariance matrices.
Sequential Pattern Recognition: Hidden Markov Models (HMM), Discrete HMM.

Unit - III **9 Hours**

Dimensionality Reduction:
Introduction to Data Reduction, Principal Component Analysis (PCA) – Its relation to Eigen Analysis. Fisher Discriminant Analysis (FDA) – Generalized Eigen Analysis. Dictionary Learning Methods – Sparse Coding.

Unit - IV **9 Hours**

Classification Techniques:
Introduction to Data Classification, Unsupervised classification methods: k Means and k Nearest Neighborhood, Supervised classification methods: Neural Networks, Support Vector Machine.

Unit – V **9 Hours**

Applications of Pattern Recognition:

Overview of applications of Pattern Recognition - Text Classification, Image Classification and Speech recognition and classification.

Text Books

1. R. O. Duda, P. E. Hart and D. Stork, "Pattern Classification", (2nd. Edition), Wiley 2002,
2. C. Bishop, "Pattern Recognition and Machine Learning", Springer 2006.

Reference Books

1. S. Theodoris and K. Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press 2009 onwards.
2. Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Prentice Hall, 2008 onwards.

Course Outcome (COs)

At the end of the course, students will be able to

At the end of the course, the student will be able to	Bloom's Level
1. Apply the tree classification techniques to separate objects	L5
2. Design supervised and unsupervised classification algorithms relaying on type of applications	L5
3. Develop a statistical model for classification of information	L6
4. Apply training and learning mechanism to develop classification and recognition techniques	L5

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
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 information to provide valid conclusions.	4
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and	5

modelling to complex engineering activities with an understanding of the limitations.

6	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. PPT	1. IA
2. Video	2. Assignments
3. Matlab tool	3. Seminars
	4. Mini projects

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of assignments (Two) / activity	Seminar/ Mini project	Total Marks
Maximum Marks:	30	10	10	50

- Writing two IA tests is compulsory.
- **Minimum marks required to qualify for SEE:** 20

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – II: Optical Networks

Course Code	18DCN232	**Credits**	4
Course type	PE – II	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2. Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.
3. Learn the various optical source materials, LED structures, quantum efficiency, Laser diodes.
4. Learn the fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles of WDM.
5. Acquire knowledge about fault and congestion management.

Unit - I 9 Hours

Client Layers of the Optical Layer: SONET/SDH: Multiplexing, CAT and LCAS, Sonnet/SDH Layers, SONET Frame Structure, SONET/SDH Physical Layer, Elements of a SONET/SDH Infrastructure.

Optical Transport Network: Hierarchy, Frame Structure, Multiplexing, Generic Framing **Procedure Ethernet:** Frame Structure, Switches, Ethernet Physical Layer, Carrier Transport IP: Routing and Forwarding, Quality of Service.

Multiprotocol Label Switching: Labels and Forwarding, Quality of Service, Signaling and Routing, Carrier Transport, Resilient Packet Ring: Quality of Service, Node Structure, Fairness**.**

Storage-Area Networks: Fiber Channel.

Unit – II 9 Hours

WDM Network Elements: Optical Line Terminals, Optical Line Amplifiers, Optical Add/Drop Multiplexers: OADM Architectures, Reconfigurable OADMs Optical Cross connects: All-Optical OXC Configurations.

Unit – III **9 Hours**

Control and Management Network Management Functions: Management Framework, Information Model, Management Protocols. Optical Layer Services and Interfacing, Layers within the Optical Layer, Multivendor Interoperability.

Performance and Fault Management: The Impact of Transparency, BER measurement, Optical Trace, Alarm Management, Data Communication Network (DCN) and Signaling, Policing, Optical Layer Overhead, Client Layers.

Configuration Management: Equipment Management, Connection Management, Adaptation Management. Optical Safety: Open Fiber Control Protocol.

Unit – IV **9 Hours**

Protection in SONET/SDH: Point-to-Point Links, Self-Healing Rings, Unidirectional Line-Switched Rings, Bidirectional Line-Switched Rings, Ring Interconnection and Dual Homing, Protection in the Client Layer: Protection in Resilient Packet Rings, Protection in Ethernet, Protection in IP, Protection in MPLS, Why Optical Layer Protection: Service Classes Based on Protection. Optical Layer Protection Schemes: 1+1 OMS Protection, 1:1 OMS Protection, OMS-DPRing, OMS-SPRing, 1:N Transponder Protection, 1+1 OCh Dedicated Protection, OCh-SPRing, OCH-Mesh Protection, GMPLS Protection, Interworking between Layers.

Unit – V **9 Hours**

WDM Network Design: Cost Trade-OFFS: A Detailed Ring Network Example LTD and RWA Problems, Light path Topology Design, Routing and Wavelength Assignment, Wavelength Conversion. Dimensioning Wavelength- Routing Networks, Statistical Dimensioning Models: First-Passage Model, Blocking Model, Maximum Load Dimensioning Models: Offline Light Path Requests, Online RWA in Rings.

Text Book

1. Rajeev Ramaswamy, Kumar N Sivarajan and Galen H Sasaki, "Optical Networks", Elsevier Publication 3rd Edn. (onwards), 2009.

Reference Book

1. Uyless Black, "Optical Networks-Third generation transport system", Pearson, 2013 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Design a system, component or process as per needs and specification. .	L6
2. Gain knowledge on optical network architectures ranging from optical access networks to backbone optical transport networks.	L2, L3
3. Gain the knowledge on methodologies of optical network design optimization;	L2, L3
4. Explore techniques of optical network survivability.	L2
5. Solve the Problems in the discipline of optical networks.	L5

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Seminar / Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – II: Cyber Physical Systems

Course Code	18DCN233	**Credits**	4
Course type	PE – II	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand the concept of cyber physical systems (CPS) and know the fundamentals research challenges in this area.
2. Understand the networked interoperability in heterogeneous CPS systems.
3. Improving critical reading, presentation, and research skills.
4. Understand feedback control and closed loop design in new CPS systems

Pre-requisites: Background in embedded systems and computer networking is necessary.

Unit – I **9 Hours**

Introduction, Modeling Dynamic Behaviors, Basics of Discrete systems, Hybrid systems, Hierarchical State machines.

Self-learning Topics: Data flow and timed models of computation.

Unit – II **9 Hours**

Embedded processors, Types and parallelism, Memory Architecture, Technology Heirarchy and Models.

Unit - III **9 Hours**

I/O, I/O hardware, Sequential Software, Analog/Digital Interface, Multitasking, Imperative programs and threads, Processes and Message passing, Scheduling basics, Rate monotonic, Earliest Deadline first.

Self-learning Topics: Scheduling and Mutual Exclusion, Multiprocessor scheduling.

Unit - IV **9 Hours**

Invariants and temporal logic, linear temporal logic, equivalence and refinement, Models as specifications, Type equivalence and refinement.

Unit - V **9 Hours**

Open and closed systems, Reachability analysis, Abstraction in model checking, Quantitative analysis, Factors determining execution time, Execution time analysis.

Text Books

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems - A Cyber-Physical Systems Approach", 1st Edition, 2014 and onwards.
2. Other readings for this course will be in the form of research papers which will be made available to students during course delivery.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Understand the concept of cyber physical systems.	L2
2. Examine the current state of art in CPS systems and applications.	L3
3. Recognize how to model sensor and actuators in system design.	L3
4. Learn system-modeling techniques and timed automata.	L2
5. Examine real-time scheduling method and know how to analyze timing properties with physical constraints.	L4

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40

3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – II: Ad-hoc Networks

Course Code	18DCN234	**Credits**	4
Course type	PE – II	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand the constraints of the wireless physical layer that affect the design and performance of ad hoc and sensor networks, protocols, and applications.
2. Get skilled in wireless networks technology platforms and standards.
3. Learn real time traffic support in wireless networks with working principles of wireless LAN.
4. Understand the Principles of Ad hoc networks.
5. Realize the necessity for mesh networks.

Unit – I 9 Hours

AD-HOC MAC:

Introduction, Issues in Ad-Hoc Wireless Networks. MAC Protocols – Issues, Classifications of MAC protocols, Multi-channel MAC & Power control MAC protocol.

Unit – II 9 Hours

AD-HOC Network Routing & TCP:

Issues, Classifications of routing protocols – Hierarchical and Power aware. Multicast routing – Classifications, Tree based, Mesh based. Ad Hoc Transport Layer Issues. TCP Over Ad Hoc – Feedback based, TCP with explicit link, TCP-Bus, Ad Hoc TCP, and Split TCP.

Unit - III 9 Hours

WSN–MAC:

Introduction, Sensor Network Architecture, Data dissemination, Gathering. MAC Protocols – self-organizing, Hybrid TDMA/FDMA and CSMA based MAC.

Unit - IV 9 Hours

WSN Routing, Localization & QOS Issues in WSN Routing: OLSR, AODV. Localization, Indoor and Sensor Network, Localization. QoS in WSN.

Unit - V 9 Hours

Mesh Networks:

Necessity for Mesh Networks – MAC enhancements – IEEE 802.11s Architecture – Opportunistic routing – Self configuration and Auto configuration – Capacity Models – Fairness – Heterogeneous Mesh Networks – Vehicular Mesh Networks.

Text Books

1. C. Siva Ram Murthy and B.S Manoj, "Ad-Hoc Wireless Networks–Architectures and Protocols", Pearson Education, 2004 and onwards.
2. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufman Publishers, 2004 and onwards.
3. C.K. Toh, "Ad-Hoc Mobile Wireless Networks", Pearson Education, 2002 and onwards.
4. Thomas Krag and Sebastin Buettrich, "Wireless Mesh Networking", O'Reilly Publishers, 2007 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Describe the issues in Ad-Hoc Wireless Networks.	L2
2. Understand current technology trends for the implementation and deployment of wireless ad-hoc network routing.	L2,L3
3. Describe sensor network architecture and MAC.	L2
4. Comprehend QoS Issues in WSN Routing.	L3
5. Understand the necessity for mesh networks.	L2

Program Outcome of this course (POs)	**PO No.**
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Design of Experiments**: Graduates shall possess the ability to design and conduct experiments, analyze and interpret data	2
3. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1.Black board	1. IA Tests
2.Presentation	2. Assignment
	3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50

- Writing two IA tests is compulsory.
- **Minimum marks required to qualify for SEE:** 20

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Research Methodology and IPR

Subject Code	18DCN24	**Credits**	4
Course Type	HS	**CIE Marks**	50
Hours/Week: L-T-P	4 – 0 – 0	**SEE Marks**	50
Total Hours	48	**SEE Duration**	3 Hours

Course learning objectives (CLOs):

1. To understand the need of research in the field of technology and management by learning the fundamental concepts of research methodology.
2. To enable the students to effectively communicate the innovative ideas with the help of experimental results are trained both in written and oral form.
3. To enlighten the students about the research samples and size and understand the statistical methods for analysis and inferences.
4. To understand the various validation methods by using simulation tools.
5. To gain the knowledge of IPR for the protection of the inventions and registration in and outside the India by having understood the concept and the process of Patents, Copyrights, Trademarks, Designs and Information Technology Act.

Detailed Syllabus:

Unit – I 8 Hours

Introduction to Research: Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

Research Problem: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - Reviews, treatise, monographs-patents - web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis.

Unit – II 10 Hours

Research design and methods: Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs.

Academic Writing & Presentation: Proposal submission for funding agencies, Elements of Style. Organization of proposals, Basic knowledge of funding agencies, Research report writing, Communication skills, Tailoring the presentation to the target audience – Oral presentations, Poster preparations, Submission of research articles for Publication to Reputed journals, Thesis writing, and Research report writing. Elements of excellent presentation: Preparation, Visual and Delivery. Oral Communication skills and Oral defense.

Unit – III 12 Hours

Data Collection methods and Sampling:

Sampling design, Steps in sampling design, Characteristics of a good sample design, Types of

sample designs, Sample size determination & sampling techniques: Random sampling, stratified sampling, systematic sampling and cluster sampling.

Measurement and scaling techniques, Methods of data collection, Collection of primary data, Data collection instruments.

Statistical Analysis and Inference:

Statistical Distributions and their applications: Binomial, Poisson, Normal, Exponential, Weibull and Geometric Distributions.

Large Sample Tests and Small Sample Tests: Student–t-test, F-test and $\chi 2$ test and their applications in research studies.

Unit – IV **10 Hours**

Testing of hypotheses - Basic concepts, Procedure for hypotheses testing, formulation of hypotheses and testing of the same, Data analysis with Statistical Packages, Analysis of variance.

Unit – V **8 Hours**

Ethical and Moral Issues in Research, Plagiarism, tools to avoid/check plagiarism

Intellectual Property Rights: Invention and Creativity, Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs), Patents and process of patenting, Copyrights, Trademarks.

Books

1. Ganesan R, Research Methodology for Engineers, MJP Publishers, Chennai, 2011.
2. Kothari C.K., Research Methodology- Methods and Techniques (New Age International, New Delhi), 2004.
3. R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
4. T. Ramappa, Intellectual Property Rights under WTO, S. Chand.
5. Keith Eugene Maskus, Intellectual Property Rights in the Global Economy, Institute for International Economics, Washington, DC, 2000.
6. Mark Lemley, Peter Menell, and Robert P. Merges, Intellectual Property in the New Technological Age:2016.
7. Subbarau NR, Handbook on Intellectual Property Law and Practice, S Viswanathan Printers and Publishing Private Limited,1998.

Course Outcome (COs)

CO	At the end of the course, the student will be able to	Bloom's Level
1.	Identify and formulate the research problems process and preparation of research design methods and collection of research data.	L1
2.	Understand the purpose and process of techno-managerial research writing, documentation and oral communication.	L1, L2
3.	Develop skills for the analysis and interpretation of research data.	L2, L3
4.	Validate the research ideas and methods through simulation.	L5
5.	Demonstrate the knowledge of IPR.	L4

	Program Outcome of this course (POs)	PO No.
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1

2.	**Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
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 information to provide valid conclusions.	4
5.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	6
6.	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	8
7.	**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. (PO9)	10
8.	**Project Management and Finance:** Demonstrate knowledge and understanding of 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. (PO 10)	11
9.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods

1. Black Board Teaching
2. Power Point Presentation
3. Self-learning using online courses

Assessment methods

1. Internal Assessment
2. Assignment
3. Seminar
4. Mini-project

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Continuous Internal Evaluation (CIE):

Components	**Average of best two tests out of three**	**Average of two assignments/ activity**	**Seminar/ Mini Project**	**Total Marks**
Maximum Marks	30	10	10	50

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Lab: Cloud Computing Lab

Course Code	18DCN25	**Credits**	1.5
Course type	L1	**CIE Marks**	25 marks
Hours/week: L-T-P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	30	**SEE Duration**	3 Hours for 50 Marks

Course Learning Objectives (CLOs)

1. Learn how to use Cloud Services.
2. Implement Virtualization.
3. Implement Task Scheduling algorithms.
4. Apply Map-Reduce concept to applications.
5. Build Private Cloud.

List of Experiments:

1. Introduction to cloud computing.
2. Creating a Warehouse Application in SalesForce.com.
3. Creating an Application in SalesForce.com using Apex Programming Language.
4. Implementation of SOAP Web services in C#/JAVA Applications.
5. Implementation of Para-Virtualization using VM Ware‘s Workstation/ Oracle‘s Virtual Box and Guest O.S.
6. Installation and Configuration of Hadoop.
7. Create an application (Ex: Word Count) using Hadoop Map/Reduce.
8. Case Study: PAAS (Facebook, Google App Engine)
9. Case Study: Amazon Web Services.

Books

1. Dan C Marinescu, “Cloud Computing Theory and Practice”, Elsevier(MK) 2013.
2. Rajkumar Buyya, James Broberg and Andrzej Goscinski, “Cloud Computing Principles and Paradigms”, Willey 2014.
3. John W Rittinghouse, James F Ransome, “Cloud Computing Implementation, Management and Security”, CRC Press 2013.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom’s Level
1. Understand the cloud architecture.	L2
2. Demonstrate the installation virtual machines on open source OS	L2
3. Implement Infrastructure, storage as a Service.	L3
4. Design and Implement applications on the Cloud.	L6
5. Understand the cloud services.	L2

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

Assessment methods

1. Internal Test
2. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Lab test	Total Marks
Maximum Marks: 25	10	10	5	25
➢ **Minimum marks required to qualify for SEE:** 13				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.**

Initial write up	2*10 = 20 marks	
Conduct of experiments	2*10 = 20 marks	50 marks
Viva- voce	10 marks	

- **Submission and certification of lab journal is compulsory to qualify for SEE.**
- **Minimum marks required in SEE to pass: 20/50 (10/25)**
- **Viva-voce shall be conducted for individual student and not in a group.**

Lab: Applied Digital Signal Processing Lab

Course Code	18DCN26	**Credits**	1.5
Course type	L2	**CIE Marks**	25 marks
Hours/week: L-T-P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	30	**SEE Duration**	3 Hours for 50 Marks

Course Learning Objectives (CLOs)

1. To enable the student, understand the various basic operations on the discrete time signals.
2. To enable the student, to understand and apply FIR and IIR filter design techniques to a given application.
3. To enable the student, understand the importance of cascaded and parallel realization of IIR filters.
4. To enable the student, appreciate the necessity of Lattice realization of FIR filters.
5. To compare the various time frequency analysis techniques.

List of Experiments:

1. Generate various fundamental discrete time signals and perform basic operations on signals (Multiplication, Folding, Scaling and convolution)
2. Find out the DFT and IDFT of a given sequence without using inbuilt instructions.
3. Up sampling & down sampling of a given sequence and frequency domain analysis.
4. Filtering of a noisy signal using IIR (Chebychev Type I, II and Buttorworth) Filters.
5. Recursive digital filter structure realizations (cascade and parallel structures).
6. FIR filter realization using frequency sampling structure.
7. Design and synthesis of FIR filter using windows (Hamming, Hanning, Rectangular, Bartlett etc,.).
8. Simulation of Goertzel algorithm.
9. Time-Frequency Analysis with the STFT and Wavelet Transform.
10. Signal Reconstruction from Discrete Wavelet Transform Coefficients.

All Experiments shall be simulated using MATLAB except for 4, 5, 7 which need to be implemented using DSP kit.

Text Books

1. E. C. Ifeachor and B. W. Jervis, “Digital Signal Processing: A Practical Approach”, Upper Saddle River, Prentice Hall Publication, 2002.
2. Roberto Cristi, “Modern Digital Signal Processing”, Thomson Brooks Cole Publications, 2004.
3. Gilbert Strang and Truong Nguyen, “Wavelets and Filter Banks”, Wellesley-Cambridge Press,1996.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom’s Level
1. Explain basic operation on discrete time signals.	L1

2.	Implement forward and inverse Fourier transforms.	L3
3.	Design and realize digital IIR filters.	L6
4.	Design and realize FIR filters.	L6
5.	Compare the various time frequency analysis techniques.	L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Fundamentals of Engineering**: Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Electronics and Communication Engineering.	1
2.	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
3.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Assessment methods

1. Internal Test
2. Activity
3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Lab test	Total Marks
Maximum Marks: 25	10	10	5	25
➢ **Minimum marks required to qualify for SEE:** 13				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.**

Initial write up	2*10 = 20 marks	
Conduct of experiments	2*10 = 20 marks	50 marks
Viva- voce	10 marks	

- **Submission and certification of lab journal is compulsory to qualify for SEE.**
- **Minimum marks required in SEE to pass: 20/50 (10/25)**

Viva-voce shall be conducted for individual student and not in a group.

Error Control Coding

Course Code	18DCN41	**Credits**	4
Course type	PC1	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand the concepts of modern algebra that are necessary to understand the Error Control Coding, also, Linear Block is introduced and develops error detection capability of linear codes.
2. Appreciate Several important classes of linear codes in communication along with Reed-Muller codes are presented and the basic structure and properties of cyclic codes are explained with syndrome-based decoding methods.
3. Design the error detection and correction system using BCH codes for error detection and implement hardware and software for BCH decoders.
4. Understand the importance of majority-logic decodable codes and learn basic state diagram to study convolutional code structure and distance properties along with Viterbi decoding algorithm.
5. Provide comprehensive introduction to new advanced coding techniques namely, concatenated codes, parallel concatenation or turbo coding, and presents methods for correcting the burst errors and combinations of burst and random errors commonly encountered on fading channels.

Pre-requisites:

1. Digital Communication
2. Information Theory Coding

Unit – I 9Hours

Introduction to algebra: Groups, Fields, binary fields arithmetic, Construction of Galois Fields GF (2^m) and its properties, Computation using Galois filed GF (2^m) arithmetic, Vector spaces and Matrices.

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, decoding circuits.

Unit – II 9 Hours

Important Linear block codes: Hamming codes, Reed-Muller codes. Golay codes, Product codes and interleaved codes.

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding using multiplication circuits, Systematic cyclic codes - Encoding using feedback shift register circuits, generator matrix for cyclic code, Syndrome computing and error detection, Meggitt decoder.

Unit – III **9 Hours**

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois fields arithmetic, Implementation of error correction.

Non-binary BCH codes: q-ary linear block codes, Primitive BCH codes over GF(q), Reed - Solomon codes, decoding of non-binary BCH and RS codes: The Berlekamp - Massey Algorithm.

Unit – IV **9 Hours**

Majority Logic decodable codes: One -step majority logic decoding, One-step majority logic decodable codes, Two-step majority logic decoding, Multiple-step majority logic decoding.

Convolution codes: Encoding of convolutional codes, Structural properties, Distance properties, Viterbi decoding algorithm for decoding, Majority logic decoding.

Unit –V **9 Hours**

Concatenated codes and Turbo codes: Single level concatenated codes, Multilevel concatenated codes, Introduction to Turbo coding and their distance properties, design of Turbo codes.

Burst - error - Correcting codes: Introduction, Decoding of Single-Burst-Error-Correcting Codes Cyclic codes, Single-Burst-Error-Correcting Codes, Burst and random error correcting codes, Burst-Error-Correcting Convolutional Codes.

Text Books

1. Shu Lin and Daniel J. Costello, Jr., "Error Control Coding: Fundamentals and Applications," Pearson Education, Prentice Hall.

Reference Books

1. Blahut R. E, "Theory and Practice of Error Control Codes", Addisson Wesley.
2. Stephen B. Wicker, "Error Control Systems for Digital Communication and Storage," Prentice Hall.
3. Peterson, W. W. and E.J. Weldon, Jr., "Error-Correcting Codes", the M.I.T. Press, Cambridge.

Tutorial

1. Write MATLAB program to verify that $1 + X + X^3$ is a primitive polynomial; that is, it divides $X^7 - 1$ but not $X^n - 1$ for $0 < n < 7$.
2. Write MATLAB program to convert the power representation to the polynomial representation for Galois field.
3. Encoding messages for a forward error correction system with a given **Linear block code,** decode the encoded messages and verify through MATLAB simulation.
4. Encoding the messages for a communication system with a given **Cyclic polynomial code,** decode the encoded messages and verify through simulation.
5. Demonstrate the use of **Binary Cyclic code** in communication system using Simulink.
6. Write a MATLAB program to perform **BCH** encoding and decoding.
7. Write a MATLAB program to perform **RS** encoding and decoding.

8. Write a MATLAB program that **convolutionally** encodes a given binary data sequence and decode binary convolutional codes using the **Viterbi algorithm**.
9. Write MATLAB program to demonstrate other **Channel coding** schemes and compare the performance.
10. Simulate the performance of concatenation of the (2,1,3) **convolutional code** and the (7,4) **RS code**. Compare the error probability with that of the individual codes.
11. Demonstrate the **Burst-error correcting** codes applicable to communication systems
12. Write a MATLAB program to underline the importance of **Turbo codes** in communication system.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Apply the concept of modern linear algebra for the error control coding technique and demonstrate efficient optimized linear block coder and decoder for communication systems.	L2, L3
2. Develop and analyze the encoding and decoding procedures of cyclic codes.	L4, L3
3. Apply linear block code and BCH code for error detection and correction.	L3
4. Analyze the performance of majority logic decoder and study applicability to convolutional codes.	L4
5. Outline the application of concatenated, turbo, burst-error corrections codes in fading channel.	L2

Program Outcome of this course (POs)	**PO No.**
1. **Fundamentals of Engineering:** Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Digital Communication and Networking.	1
2. **Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
4. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
5. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. Classroom Teaching	1. Internal Assessment Tests

2. Presentation
3. Animations
4. Videos

2. Assignments
3. Seminar
4. IEEE paper implementation

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – III: High Performance Computing

Course Code	18DCN421	**Credits**	4
Course type	PE – III	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. To know the concepts of parallel processing.
2. To understand the limitations and issues in HPC.
3. To learn the benchmarking standards in HPC.
4. To understand accelerated HPC.
5. To study power-aware HPC design.

Unit – I **9 Hours**

Parallel Processing Concepts; Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation; Parallel architectures: superscalar architectures, multi-core, multi-threaded, server and cloud.

Unit – II **9 Hours**

Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms.

Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques.

Unit – III **9 Hours**

Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service.

Unit – IV **9 Hours**

Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE.

Unit – V **9 Hours**

Power-aware HPC Design: Computing and communication, processing, memory design, interconnect design, power management;

Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

Lab Sessions to cover: HPC programming assignments: Hands on experiment and programming on parallel machine and HPC cluster using Pthread, OpenMP, MPI, Nvidia Cuda and Cilk. Hands on experiments on standard multiprocessor simulator or cloud simulator. (Ref. https://www.iitg.ac.in/asahu/cs528/)

Text Books

1. Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers (1st ed.). CRC Press, Chapman & amp; Hall/CRC Computational Science, India, 2010.
2. Vipin Kumar, Ananth Grama, Anshul Gupta, George Karypis. Introduction to Parallel Computing (2nd ed.). Pearson India. 2003.
3. John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach (5th ed.). Elsevier India Pvt. Ltd. 2011.
4. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.
5. Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011.

Reference Books

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing, 1997 and onwards.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004 and onwards.
3. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999 and onwards.
4. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Wiley- India Edition, 2006 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom’s Level
1. Model speech production system and describe the fundamentals of speech.	L6
2. Extract and compare different speech parameters.	L5
3. Choose an appropriate statistical speech model for a given application.	L3
4. Design a speech recognition system.	L6
5. Use different speech synthesis techniques.	L4

Program Outcome of this course (POs)	PO No.
1. **Fundamentals of Engineering:** Graduates shall be able to understand and apply the basic mathematical and scientific concepts in the field of Digital Communication and Networking.	1
2. **Design of Experiments:** Graduates shall possess the ability to design and conduct experiments, analyse and interpret data.	2
3. **Modern tool Usage:** Graduates shall possess critical thinking abilities, problem solving skills and familiarity with the necessary computational tools and procedures.	5
4. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. Blackboard Teaching	1. Internal Assessment
2. Presentation and Simulation	2. Case Study
3. Videos	3. Assignment

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50

- Writing two IA tests is compulsory.
- **Minimum marks required to qualify for SEE:** 20

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – III: Human Computer Interaction

Course Code	18DCN422	**Credits**	4
Course type	PE – III	**CIE Marks**	50
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	100
Total Hours:	45	**SEE Duration**	3 Hours

Course Learning Objectives (CLOs)

1. Learn the basics of human-computer interaction, interactivity, interaction styles, models of interaction and framework of human-computer interaction.
2. Study how software engineering and the design process relate to interactive system design and understand the design rules to develop an effective design process and a universal design.
3. Understand different kinds of software engineering formalisms that can be used to specify the behavior of specific systems and study cognitive models, interaction models and cognitive architectures.
4. Learn the programming support tools available for implementing interactive systems and improve the abstraction by use of toolkits. Study the evaluation techniques and design of user support systems.
5. Study the implementation and applications of groupware, ubiquitous computing and augmented realities applied to interactive systems.

Unit – I **9 Hours**

Foundation:

Introduction to human and computer, The Interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of WIMP interface, Interactivity.

Self – Learning Topic: Paradigms for interaction

Unit – II **9 Hours**

The Design Process:

Interaction design basics: the process of design, user focus, scenarios, navigation design, screen design and layout, iteration and prototyping. HCI in software process: software life cycle, usability engineering, iterative design and prototyping, design rationale. Design rules: principles, standards, guidelines, golden rules and heuristics, HCI patterns. Universal design: Universal design principles, Multi-modal interaction.

Self – Learning Topic: Designing for diversity

Unit – III **9 Hours**

Models of Interactive Systems:

Standard formalism, Cognitive models: Goal and task hierarchies, Linguistic models, challenge of display-based systems, Physical and device models, Cognitive architectures. Interaction models, modeling rich interaction.

Self – Learning Topic: Socio-organizational issues and stakeholder requirements

Unit – IV **9 Hours**

Implementation and Evaluation:

Implementation support: Elements of windowing systems, Programming the application, using toolkits, User interface management systems. Evaluation techniques: Goals of evaluation, Evaluation through expert analysis, choosing an evaluation method. User support: Requirements of user support, Approaches to user support, Adaptive help systems, Design of user support systems.

Self – Learning Topic: Evaluation through user participation

Unit – V **9 Hours**

Interactive System Applications:

Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, implementing synchronous groupware. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization.

Self – Learning Topics: Hypertext, Multimedia and the World Wide Web

Text Books

1. Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russell Beale, "Human-Computer Interaction", 3rd Edition, Pearson Education Limited, 2004.

Reference Books

1. Preece, J., Rogers, Y., & Sharp, H., "Interaction design: Beyond human-computer interaction", 4th Edition, John Wiley & Sons Limited, 2015.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Understand the basic elements of human-computer interaction.	L2
2. Apply software engineering process and design rules in order to develop reliable and effective design process and further a universal design.	L3
3. Analyze different models of interactive systems and infer on the model suitable for required behavior of the systems using software engineering formalisms.	L4
4. Implement an interactive system by using programming support tools and toolkits, perform system evaluation and design user support system.	L5
5. Apply groupware, ubiquitous computing and augmented reality technologies in order to develop a better interactive system.	L3

Program Outcome of this course (POs)

	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1

2.	**Problem Analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
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 information to provide valid conclusions.	4
5.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. Classroom Teaching (Blackboard)	1. IA test
2. Presentation	2. Assignment
3. Videos	3. Mini Project
4. Notes	4. Seminar

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two assignments / activity	Mini Project/ Seminar	Total Marks
Maximum Marks: 50	30	10	10	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: Minimum IA test marks (Average) 10 out of 25 AND total CIE marks 20**

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass: 40**
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – III: CMOS RF Circuit Design

Course Code	18DCN423	**Credits**	4
Course type	PE – III	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	100 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Introduce to Core RF principles, including noise and nonlinearity, with ties to analog design, microwave theory, and communication systems.
2. An intuitive treatment of modulation theory and wireless standards from the standpoint of the RF IC designer and study of transceiver architectures.
3. Introduction of CMOS technology in the design of RF circuits and study the MOSFET behavior at RF frequencies.
4. Overview of RF filter design, its components and modeling.
5. Insight into the circuit designs namely: LNA, VCO and RF Synthesizers.

Unit – I 9 Hours

Introduction to RF Design and Wireless Technology: Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Inter symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion. Problems as applicable.

Unit – II 9 Hours

RF Modulation: Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures, Direct conversion and two-step transmitters. Problems as applicable.

Unit – III 9 Hours

RF Testing: RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers. **BJT and MOSFET behavior at RF Frequencies:** BJT and MOSFET behavior at RF frequencies, modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation. Problems as applicable.

Unit – IV 9 Hours

RF Circuit Design: Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Various mixers- working and implementation. Problems as applicable.

Unit – IV **9 Hours**

Design of Oscillator and PLL: Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers. Problems as applicable.

Self-Learning: Design issues in integrated RF filters.

Text Books

1. B. Razavi, "RF Microelectronics", 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 1998.
2. R. Jacob Baker, H.W. Li, and D.E. Boyce "CMOS Circuit Design, layout and Simulation", 2nd Edition, Prentice Hall, India,1998.

Reference Books

1. Thomas H. Lee "Design of CMOS RF Integrated Circuits" Cambridge University press, 1998.
2. Y.P. Tsividis, "Mixed Analog and Digital Devices and Technology", Tata Mcgraw Hill, 1996.
3. Debatosh Guha, Yahia M M Antar, "Microstrip and Printed Antennas: New Trends, Techniques and Applications" Wiley, 2011.
4. Jan Crols, Michiel Steyaert, "CMOS Wireless Transceiver Design", Kluwer Academic Publishers, 1997.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain the basic concept of parameters used in RF design and Indentify the need of parameters such as noise, sensitivity etc.	L2
2. Describe the modulation techniques for RF circuits and hence the design of transmitter and receiver.	L2, L3
3. Describe the behaviour of BJT and MOSFET at RF frequency and their performance parameters.	L2
4. Design and analysis of RF filters, LNA and mixers.	L3, L4
5. Design and analysis of VCO and RF synthesizers.	L3, L4

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2. **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.	3
3. **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.	4

4. **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. 5
5. **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 10
6. **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 12

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentation
3. Video presentations / circuit simulations
4. MOOC and NPTEL courses

Assessment methods

1. IA test
2. Assignment
3. Seminar
4. Mini Project

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of assignments (Two) / activity	Seminar/ Mini Project	Total Marks
Maximum Marks: 50	30	10	10	50

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Elective – III: Real – Time Systems

Course Code	18DCN424	**Credits**	4
Course type	PE – III	**CIE Marks**	50 marks
Hours/week: L-T-P	4 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. To understand the concept of real-time and real-time applications.
2. To understand the different real-time scheduling algorithms.
3. To study the different protocols & tasks in real-time systems.
4. Study the features of various real-time operating systems.
5. Familiarize real-time communication and applications of real-time databases.

Unit – I **9Hours**

Introduction: What is real time? Applications of real-time systems, A basic model of Real-time system, Characteristics of Real-time system, Safety and reliability, Types of real-time tasks, timing constraints, modeling timing constraints.

Unit – II **9 Hours**

Real Time Task Scheduling: Some important concepts, types of real-time tasks and their characteristics, task scheduling, clock driven scheduling, hybrid schedulers, event-driven scheduling, Earliest deadline first scheduling, Rate monotonic algorithm, Some issues associated with RMA, Issues in using RMA in practical situations.

Unit – III **9Hours**

Handling Resource Sharing and Dependencies Among Real Time Tasks: Resource sharing among real-time tasks, Priority inversion, Priority Inheritance protocol, highest locker protocol, priority ceiling protocol, different types of priority inversions in PCP, Important features of PCP, some issues in using a resource sharing protocol, handling task dependencies.
Scheduling Real Time Tasks in Multiprocessor and Distributed Systems: Multiprocessor task allocation, Dynamic allocation of tasks, fault-tolerant scheduling of tasks, clocks in distributed RTS, centralized clock synchronization, distributed clock synchronization.

Unit – IV **9Hours**

Commercial Real Time Operating Systems: Time services, Features of real-time operating systems, Unix as a real-time operating system, Unix-based real-time operating systems, Windows as a real-time operating system, POSIX, A survey of contemporary real-time operating systems, benchmarking real-time systems.

Unit – V **9Hours**

Real Time Communication: Examples of real-time communication in applications, basic concepts, Real-time communication in LAN, Soft Real-time communication in LAN, Hard Real-time communication in LAN, Bounded Access Protocol, Performance comparison, Real-time comparison over internet, Routing, Multicast routing, resource sharing, traffic shaping and policing, scheduling mechanisms, QOS models.

Real Time Databases: Example applications of real-time databases, Review of basic database concepts, real-time databases, characteristics of temporal data, concurrency control in real-time databases, commercial real-time databases.

Text Books

1. Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
2. Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
3. Krishna and Shin, "Real-Time Systems," Tata McGraw Hill. 1999.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Explain the concept of real-time and apply it to different real-time applications.	L2, L3
2. Explain real-time scheduling and apply the knowledge to real-time schedulers.	L2, L3
3. Apply the concept of real-time and understand working of protocols.	L3
4. Analyze the working of operating system to real-item systems.	L4
5. Demonstrate real-time communication and develop real-time databases.	L4

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems**.**	1
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
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.	3
4. **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.	12

Course delivery methods	Assessment methods
1. Blackboard Teaching	1. Assignments
2. Presentation	2. Internal Assessment Tests
3. Notes	3. Tutorials

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	**Average of assignments (Two) / activity**	**Seminar/ Mini Project**	Total Marks
Maximum Marks: 50	30	10	10	50
➢ Writing two IA tests is compulsory. ➢ **Minimum marks required to qualify for SEE:** 20				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**40
3. Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Bloom's Taxonomy of Learning Objectives

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 by Benjamin Bloom and modified during the 1990's by a new group of cognitive psychologists, led by Lorin Anderson (a former student of Bloom's) to make it relevant to the 21st century. The **revised taxonomy** given below emphasizes what a learner "Can Do".

Lower order thinking skills (LOTS)		
L1	Remembering	Retrieve relevant knowledge from memory.
L2	Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.
L3	Applying	Carry out or use a procedure in a given situation – using learned knowledge.
Higher order thinking skills (HOTS)		
L4	Analyzing	Break down knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.
L5	Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.
L6	Creating	Combining or reorganizing elements to form a coherent or functional whole or into a new pattern, structure or idea.