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

M. Tech. Scheme and Syllabus (2020 Scheme)

1st to 4th Semester

Digital Communication and Networking (DCN)

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 post graduates will acquire core competence in Digital Communication and Networking fundamentals necessary to formulate, analyze, and solve problems in communication and networking domain and to pursue advanced study or research.
2.	The post graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth, and self-confidence to adapt to ongoing technological developments.
3.	The post 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.	An ability to independently carry out research /investigation and development work to solve practical problems.
2.	An ability to write and present a substantial technical report/document.
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking 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.

2020-21 Scheme of Teaching and Examination

1st to 4th Semester M. Tech. (Digital Communication and Networking)

Total credits for M. Tech. Program: 88

	Semester	Credits per Sem	Total credits
1st year	1	21	42
	2	21	
2nd year	3	23	46
	4	23	
	Total	**88**	**88**

Curriculum frame work:

Sl. No.	Course		Credits
1	Professional Core	PC	36
2	Professional Elective	PE	12
3	Online Courses (SWAYAM)	PC	09
4	Minor Project / Skill Development / Teaching Assistantship		04
5	Internship	PI	05
6	Project	PR	22
	Total		88

Theory Course Credits		Online Course Credits	
Duration of course	**Credits**	**Online course duration**	**Credits**
50 hours of course content	4	04 weeks	1
40 hours of course content	3	08 weeks	2
Lecture (L) One Hour /week	1	12 weeks	3
Practicals (P) Two hours /week	1		

1st Sem M. Tech.												
S.No.	**Course Code**	**Course**		**Contact Hours**	**Contact Hours/week**	**Credit Allocation**			**Total credits**	**Marks**		
				L – T – P		**L**	**T**	**P**		**CIE**	**SEE**	**TOTAL**
1.	20DCN11	Applied Engineering Mathematics	PC1	4 – 0 – 0	4	4	0	0	4	50	50	100
2.	20DCN12	Advanced Digital Communication	PC2	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
3.	20DCN13	Advanced Computer Networks	PC3	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
4.	20DCN14X	Elective-I	PE- I	4 – 0 – 0	4	4	0	0	4	50	50	100
5.	20DCN15	SWAYAM Online course	OC						3			
6.	20DCN16	Minor project / Skill Development / Teaching assistantship							2	25		25
		Total		14 – 0 – 4	18	14	0	2	21	275	250	525

- **OC: Student can register for one course of 12 weeks OR two courses (4 weeks+ 8weeks) to earn 3 credits**
- **Maximum TWO courses should be integrated type**

Course Code	**Professional Elective – I**
20DCN141	Advanced Multimedia Communication
20DCN142	Information Security
20DCN143	Remote Sensing and GIS
20DCN144	Machine Learning Algorithms

2nd Sem M. Tech.												
S.No.	**Course Code**	**Course**		**Contact Hours**	**Contact Hours/week**	**Credit Allocation**			**Total credits**	**Marks**		
				L – T – P		**L**	**T**	**P**		**CIE**	**SEE**	**TOTAL**
1.	20DCN21	Cloud Computing	PC1	4 – 0 – 0	4	4	0	0	4	50	50	100
2.	20DCN22	Applied DSP	PC2	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
3.	20DCN23	Research Methodology and IPR	PC3	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
4.	20DCN24X	Elective-II	PE- I	4 – 0 – 0	4	4	0	0	4	50	50	100
5.	20DCN25	SWAYAM Online course	OC						3			
6.	20DCN26	Minor project / Skill Development / Teaching assistantship							2	25		25
		Total		14 – 0 – 4	18	14	0	2	21	275	250	525

- **OC: Student can register for one course of 12 weeks OR two courses (4 weeks+ 8weeks) to earn 3 credits**
- **Maximum TWO courses should be integrated type**

Course Code	Professional Elective – II
20DCN241	Pattern Recognition and Classification
20DCN242	Optical Networks
20DCN243	Cyber Physical Systems
20DCN244	Ad-hoc Networks

3rd Sem M. Tech.												
S.No.	**Course Code**	**Course**		**Contact Hours**	**Contact Hours/week**	**Credit Allocation**			**Total credits**	**Marks**		
				L – T – P		**L**	**T**	**P**		**CIE**	**SEE**	**TOTAL**
1.	20DCN31	Error Control Coding	PC1	4 – 0 – 0	4	4	0	0	4	50	50	100
2.	20DCN32	Advances in Antenna and Microwave Engineering	PC2	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
3.	20DCN33	Adaptive Signal Processing	PC3	**3 – 0 – 2**	5	3	0	1	4	50+25	50+25	150
4.	20DCN34X	Elective - III	PE- I	4 – 0 – 0	4	4	0	0	4	50	50	100
5.	20DCN35	SWAYAM Online course	OC						3			
6.	20DCN36	Project Phase-1	PR1						4	50		50
		Total		14 – 0 – 4	18	14	0	2	23	300	250	550

- **OC: Student can register for one course of 12 weeks OR two courses (4 weeks+ 8weeks) to earn 3 credits**
- **Maximum TWO courses should be integrated type**

Course Code	**Professional Elective – III**
20DCN341	High Performance Computing
20DCN342	Human Computer Interaction
20DCN343	CMOS RF Circuit Design
20DCN344	Real Time Systems

4th Sem M. Tech.								
S.No.	**Course Code**	**Course**		**Contact Hours/week**	**Total credits**	**Marks**		
						CIE	**SEE**	**TOTAL**
1.	20DCN41	#Internship	PI	6 – 8 weeks	5	50	50	100
2.	20DCN42	Project Phase -2	PR2		4	50(25+25)	--	50
3.	20DCN43	Project Phase -3	PR3		4	50(25+25)	--	50
4.	20DCN44	Evaluation of Project and Viva-voce	PR4		10	--	150(50+100)	150
		Total			23	150	200	350

#Internship: 6 to 8 weeks either in one slot or multiple slots during vacation between 2nd and 3rd sem / between 3rd and 4th sem

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)

Applied Engineering Mathematics

Course Code	20DCN11	**Credits L – T – P**	4 – 0 – 0
Course type	PC1	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 10 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 10 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 10 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 10 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 10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)	CO-PSO Mapping(planned)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Advanced Digital Communication (Integrated)

Course Code	20DCN12	**Credits L-T-P**	3 – 0 – 1
Course type	PC2	**Total credits**	4
Hours/week: L-T-P	3 – 0 – 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = 0 Hrs; P = 24 Hrs Total = 64 Hrs	**SEE Marks**	50(T)+25(L) = 75 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 **8 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 **8 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 **8 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 **8 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 **8 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.

Unit – VI	**7 Hours**
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.

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	L6

maximize SNR at the receiver.

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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Classroom Teaching (Blackboard)
2. Presentations

Assessment methods

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

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					

Lab component:				
Components	Conduct of the lab	Journal submission	Lab Test	Total Marks
Lab	10	10	5	25
Total CIE: 50 (T) +25(L) = 75 marks				
Minimum score to be eligible to SEE for this course: 40% in each component				
Not eligible in any one of the components will be considered as NOT eligible for the Course				

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):			
Theory Component:			
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 out of 100**		
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.		
Lab component:			
1.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
2.	It will be conducted for 50 marks having 3 hours/2 hours duration. **It will be reduced to 25 marks for the calculation of SGPA and CGPA.**		
3.	Viva-voce is conducted for individual student.		
Total SEE: 50(T) +25(L) = 75 marks			
Minimum score for passing this course: 40% in each component compulsory			
Not eligible in any one of the components will be considered as NOT eligible for the Course			

Advanced Computer Networks (Integrated)

Course Code	20DCN13	**Credits L-T-P**	3 – 0 – 1
Course type	PC3	**Total credits**	4
Hours/week: L-T-P	3 – 0 – 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = 0 Hrs; P = 24 Hrs Total = 64 Hrs	**SEE Marks**	50(T)+25(L) = 75 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 8 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 8 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 8 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 8 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 **8 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.

Unit – VI	**7 Hours**
List of experiments	
1.	Study of networking devices, NIC card and cable crimping process needed for network deployment.
2.	Study of CISCO packet tracer.
3.	Design a local area network, configure the nodes, switches and illustrate the data flow.
4.	Simulate the different network topologies using CISCO packet tracer.
5.	Simulate Routing Information Protocol (RIP) algorithm using CISCO packet tracer.
6.	Simulate a three nodes point-to-point network with duplex links and find the number of packets dropped using TCP and UDP.
7.	Simulate data communication between single sender and multiple receiver and determine the PDR by network using TCP/UDP.
8.	Simulate an Ethernet LAN using N-nodes. Change error rate and data rate and compare the throughput.
9.	Analyze the PDR for star topology by varying the number of sender and receiver nodes.
10.	Simulate the wireless LAN and represent the packet drop and throughput graphically.
	Open ended experiment: Configuration of DHCP using CISCO packet tracer

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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Blackboard Teaching
2. Presentation
3. Notes

Assessment methods

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

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					

Lab component:				
Components	Conduct of the lab	Journal submission	Lab Test	Total Marks
Lab	10	10	5	25
Total CIE: 50 (T) +25(L) = 75 marks				
Minimum score to be eligible to SEE for this course: 40% in each component				
Not eligible in any one of the components will be considered as NOT eligible for the Course				

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):			
Theory Component:			
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 out of 100**		
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.		
Lab component:			
1.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
2.	It will be conducted for 50 marks having 3 hours/2 hours duration. **It will be reduced to 25 marks for the calculation of SGPA and CGPA.**		
3.	Viva-voce is conducted for individual student.		
Total SEE: 50(T) +25(L) = 75 marks			
Minimum score for passing this course: 40% in each component compulsory			
Not eligible in any one of the components will be considered as NOT eligible for the Course			

Professional Elective – I: Advanced Multimedia Communication

Course Code	20DCN141	**Credits L – T – P**	4 – 0 – 0
Course type	PE – I	**Total credits**	4
Hours/week: L-T-P	4 –0 – 0	**CIE Marks**	50 marks
Total Hours:	50	**SEE Marks**	50 marks

Course learning objectives	
1.	Introduce basic concepts of multimedia communication.
2.	Explore different image compression standards.
3.	Understand the concepts of digital representation of audio.
4.	Understand the importance of compression of video and audio for efficient transmission over band limited channel.
5.	Explore applications of virtual reality in entertainment, business and education.

Pre-requisites: Basics of Signals and Systems, Digital Signal Processing

Unit - I	**10 Hours**

Basics of Multimedia Technology:
Computers, Communication and Entertainment: Multimedia -An introduction: Framework for multimedia systems; multimedia devices CD Audio. CD-ROM. CD-I: presentation devices and the user interface; multimedia presentation and authoring; professional development tools: LANs & multimedia. Internet, World Wide Web & Multimedia; distribution network ATM & ADSL; multimedia servers & databases: vector graphics; 3-D graphics programs; animation techniques; shading; anti -aliasing; morphing: video on demand.

Unit - II	**10 Hours**

Image Compression & Standards:
Making still images: editing and capturing images; scanning images; computer color models: color palettes; vector drawing; 3 -D drawing and rendering; JPEG-objectives and architecture: JPEG-DCT encoding and quantization, JPEG statistical coding; JPEG predictive loss less coding; JPEG performance; Overview of other image file formats as GIF, TIFF. BMP. PNG etc.

Unit - III	**10 Hours**

Digital representation of sound: time domain sampled representation; method of encoding the analog signals; sub-band coding; Fourier method: transmission of digital sound; digital audio signal processing; stereophonic & quadraphonic signal processing; editing sampled sound

Unit - IV	**10 Hours**

MPEG Audio and Video compression standard: brief survey of speech recognition and generation; audio synthesis; Musical Instrument Digital Interface (MIDI); digital video and image Compression; MPEG Motion video compression standard; DVI technology: time-based media representation and delivery.

Unit - V	**10 Hours**

Virtual Reality
Applications of multimedia, Intelligent multimedia system, Desktop Virtual Reality (VR). VR operating System, Virtual environment displays and orientation tracking; visually coupled system requirements; intelligent VR software systems. Applications of environments in various fields viz. Entertainment. manufacturing. Business, education, etc.

Books	
	Text Books:
1.	John Villamil and Lois Molina, "Multimedia: An Introduction", Prentice Hall of India, 1997 onwards.
2.	Jose Lozano, "Multimedia Sound & Video", Pearson, 1997 onwards.
	Reference Books:
1.	John Villamil and Lois Molina, "Multimedia: Production. Planning and Delivery", Prentice Hall of India, 1997 onwards.
2.	Sinclair, "Multimedia on the PC", BPB Publications, 2008 onwards

Course delivery methods

1. Blackboard Teaching
2. Presentation
3. Notes

Assessment methods

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

Course Outcome (COs)		
At the end of the course, the student will be able to		Bloom's Level
1.	Understand and explain the basics of multimedia technology.	L2
2.	Compare different image compression standards	L4
3.	Explain the audio production and representation in digital domain	L2
4.	Explain the MPEG compression standard	L2
5.	Explain the application of virtual reality in various sectors	L2

Program Outcome of this course (POs)	PO No.
1. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – I: Information Security

Course Code	20DCN142	**Credits L – T – P**	4 – 0 – 0
Course type	PE – I	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50 marks
Total Hours:	50	**SEE Marks**	50 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 **10 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 **10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target

1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – I: Remote Sensing and GIS

Course Code	20DCN143	**Credits L – T – P**	4 – 0 – 0
Course type	PE – I	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50 marks
Total Hours:	50	**SEE Marks**	50 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 **10 Hours**

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

Unit – II **10 Hours**

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

Unit - III **10 Hours**

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

Unit - IV **10 Hours**

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

Unit - V **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)	CO-PSO Mapping(planned)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – I: Machine Learning Algorithms

Course Code	20DCN144	**Credits L – T – P**	4 – 0 – 0
Course type	PE – I	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50 marks
Total Hours:	50	**SEE Marks**	50 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 **10 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 **10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		**PSO No.**
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**

2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Cloud Computing

Course Code	20DCN21	**Credits L – T – P**	4 – 0 – 0
Course type	PC1	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 10 Hours

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 10 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 10 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 10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

	Program Specific Outcome of this course (PSOs)	PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding	**3**

	innovative solutions to contemporary issues with multidisciplinary outlook.	

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Applied DSP (Integrated)

Course Code	20DCN22	**Credits L-T-P**	3 – 0 – 1
Course type	PC	**Total credits**	4
Hours/week: L-T-P	3 – 0 – 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = Hrs; P = 24Hrs Total = Hrs	**SEE Marks**	50(T)+25(L) = 75 marks

Course Learning Objectives (CLOs)

1. To review the fundamentals of discrete time systems.
2. To explore various single rate filter design.
3. To understand the basics of multirate systems.
4. To introduce the concepts of filter banks and transmultiplexers.
5. To explore maximally decimated filter banks and time frequency representations.

Pre-requisites: Digital Signal Processing.

Unit – I — 8 Hours

Review of Spectral Analysis of Discrete time Signals and Systems:
Review of Transforms: DTFT, Z transforms, DFT computation using FFT.
Introduction real transforms: DCT and DST.
Frequency response analysis of discrete time systems: Computing frequency response of a discrete time system for sinusoidal, sum of sinusoidal and complex exponential sequences.

Unit – II — 8 Hours

Fixed Rate Filter Design and Realization:
IIR – Butterworth and Chebyshev (Type – I) LPF, HPF and BPF filter design using bilinear transformation.
FIR – Filter design using frequency sampling technique.
Realization: Lattice realization of IIR and FIR filters, state space realization of IIR and FIR filters.

Unit – III — 8 Hours

Multirate Digital Signal Processing Fundamentals:
Introduction, statement of the problem and definitions, analysis of down sampling and up sampling, sampling rate conversion by a rational factor, multi stage implementation of digital filters, efficient implementation of multirate systems, application of multirate DSP: analog to digital conversion, sampling frequency and quantization error.

Unit – IV — 8 Hours

DFT Filter Banks and Transmultiplexers:
Introduction, DFT filter banks, maximally decimated DFT filter banks and transmultiplexers, transmultiplexers, application of transmultiplexers to digital communications modulation.

Unit – V — 8 Hours

Maximally Decimated Filter Banks:
Introduction, vector spaces, two channel perfect reconstruction conditions, design of perfect reconstruction filter banks with real coefficients, lattice implementation of orthonormal filter banks, application to an audio signal.

Time frequency expansion: Short time Fourier Transform (STFT), Gabor Transform (GT), wavelet transforms.

Unit – VI		7 Hours
List of experiments		
1.	Design and synthesis of Digital IIR filters.	
2.	Design and synthesis of Digital FIR filters.	
3.	Up sampler/down sampler design.	
4.	QMF Filter design.	
5.	Study of FFT analyzer.	
6.	Simulation Adaptive Sub Band Speech Coding (ASBC)	
7.	Design and simulation of transmutiplexers.	
8.	Open ended experiment: Simulation of non-destructive testing	

Text Books

1. Roberto Cristi, "Modern Digital Signal Processing", Thomson Brooks/Cole Publishers, 2004 onwards.

Reference Books

1. N. J. Fliege, "Multirate Digital Signal Processing", John Wiley & Sons, USA,2000.
2. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education (Asia) Pte.Ltd, 2004.
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. To understand the fundamentals of discrete time systems.	L1
2. Design single rate filters.	L3
3. Understand and explain the basic building blocks of multirate systems.	L2
4. Design DFT filter banks and transmultiplexers.	L3
5. Analyze signals in time - frequency domain and desing maximally decimated filterbanks.	L4, L3

Program Outcome of this course (POs)	PO No.
1. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**

3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					
Lab component:					
Components	Conduct of the lab	Journal submission	Lab Test	Total Marks	
Lab	10	10	5	25	
Total CIE: 50 (T) +25(L) = 75 marks					
Minimum score to be eligible to SEE for this course: 40% in each component					
Not eligible in any one of the components will be considered as NOT eligible for the Course					

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):

<table>
<tr><td colspan="4">Theory Component:</td></tr>
<tr><td>1.</td><td colspan="3">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.</td></tr>
<tr><td>2.</td><td colspan="3">Minimum marks required in SEE to pass: 40 out of 100</td></tr>
<tr><td>3.</td><td colspan="3">Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.</td></tr>
<tr><td colspan="4">Lab component:</td></tr>
<tr><td rowspan="4">1.</td><td>Initial write up</td><td>10 marks</td><td rowspan="4">50 marks</td></tr>
<tr><td>Conduct of experiment(s), result and conclusion</td><td>20 marks</td></tr>
<tr><td>One marks question</td><td>10 marks</td></tr>
<tr><td>Viva-voce</td><td>10 marks</td></tr>
<tr><td>2.</td><td colspan="3">It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.</td></tr>
<tr><td>3.</td><td colspan="3">Viva-voce is conducted for individual student.</td></tr>
<tr><td colspan="4">Total SEE: 50(T) +25(L) = 75 marks</td></tr>
<tr><td colspan="4">Minimum score for passing this course: 40% in each component compulsory</td></tr>
<tr><td colspan="4">Not eligible in any one of the components will be considered as NOT eligible for the Course</td></tr>
</table>

RESEARCH METHODOLOGY AND IPR (Integrated)

Course Code	20DCN23	**Credits L-T-P**	3 – 0 – 1
Course type	PC	**Total credits**	4
Hours/week: L-T-P	3 – 0 – 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = Hrs; P = 24Hrs Total = Hrs	**SEE Marks**	50(T)+25(L) = 75 marks

Course learning objectives	
1.	Understand the basic concepts of research & its methodologies
2.	Identify & select the appropriate research/sampling design methods.
3.	Analyze and interpret the data to enable hypothesis testing
4.	Create the awareness about Intellectual Property Rights for the protection of inventions.

Unit - I	**8 Hours**

Research Methodology: Introduction

Meaning, Objectives, types, Research Approaches. Significance of Research, Research Methods versus Methodology, Research and scientific method, research Process, criteria of good research, Problems encountered by researchers.

Research Problem:

Defining a research problem, Selecting a research problem, necessity and techniques involved in defining the research problem.

Unit - II	**8 Hours**

Research Design:

Meaning, need for research design, features of a good design, important concepts relating to research design, different research designs, Basic principles of experimental designs, developing a research plan.

Sampling design:

Implications of a sample design, Steps in sample design, criteria of selecting a sampling procedure, characteristics of a good sample design, different types of sample designs, Random Sample and complex random sample designs.

Unit - III	**8 Hours**

Data Collection Methods:

Collection of Primary Data, Observation Method, Interview Method, Questionnaires, Schedules, Other Methods of Data Collection, Collection of Secondary Data, Case study method.

Processing and Analysis of Data:

Processing operations, Elements/ types of analysis, Statistics in research- measures of central tendency or statistical averages, measures of dispersion, measures of asymmetry (skewness), measures of relationship, Simple regression analysis, Multiple correlation and regression, Partial correlation, Association in case of attributes, Other measures- Index numbers, Time series analysis.

Unit - IV	**8 Hours**

Testing of hypotheses:

Basic concepts, procedure for hypothesis testing, flow diagram, Test of hypothesis, procedure for hypothesis testing, Hypothesis for means, difference between means, comparing two related samples, proportions, difference between proportions, comparing a variance to some hypothesized population variance, power of test, limitations of test of hypothesis.

Chi-sqaure test: $\chi 2$ test and their applications in research studies.

Analysis of variance: Basic principles of ANOVA, ANOVA technique, setting up of analysis of variance table, one way, ANOVA, two way ANOVA, ANOVA in Latin square Design.
Self learning topics: Analysis of Co-variance.

Unit - V	**8 Hours**
Intellectual Property Rights: **IPR-** Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures. Research ethics. **Interpretation and Report Writing**: Meaning of interpretation, Why interpretation, Technique of interpretation, Precaution in interpretation, Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Oral presentation, Mechanics of writing research report, Precautions for writing research reports.	

Unit – VI	**7 Hours**
List of experiments	
1.	Techniques for data collection [primary, secondary]
2.	Selection of sample design for a given research problem using different sample design procedures.
3.	Data Analytics relevant to various applications
4.	Regression and Correlation analysis
5.	Data Analytics relevant to various applications under probability theory
6.	Conduct an experiment on Regression and Correlation analysis
7.	Conduct an experiment using various research design techniques, like: factorial design, L S design, randomized block design, response surface methodology
8.	Conduct an experiment for testing an Hypothesis using ANOVA (1 way and 2 way ANOVA) and other Multivariate analysis

Books	
	Text Books:
1.	C R. Kothari, Research Methodology, New Age International Publishers, 2nd edition, 2007.
	Reference Books:
1.	PanneerSelvam, Research Methodology, PHI Learning Pvt. Ltd., 2007.
2.	Dr. B.L.Wadhera -Intellectual Property Rights, Universal Law Publishing Co. Ltd.. 2002
3.	William G Zikmund, Business Research Methods, Indian edition, South western Publishers, 8th Indian Reprint – 2009.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	
2.	

Course delivery methods		Assessment methods	
1.	**Chalk & talk**	1.	**Assignments**
2.	**Power Point Presentation**	2.	**IA Tests**
3.		3.	**Seminar/ Mini Project**
4.		4.	

Course Outcome (COs)

Outcomes usually follow the format: "At the end of the course, students will be able to*'insert action verb here + insert knowledge, skills, or attitudes the student is expected to develop'*](Highlight the **action verb** representing the Bloom's level.)

At the end of the course, the student will be able to		Bloom's Level
1.	Identify & select an appropriate methodology for research.	[L1]
2.	Design & Apply suitable research/sampling procedure for the research problem.	[L3]
3.	Analyze and interpret data collected.	[L4]
4.	Evaluate various approaches for hypothesis testing.	[L5]
5.	Discuss the significance of Intellectual Property Rights & report writing.	[L2]

Program Outcome of this course (POs)		PO No.
1.	An ability to independently carry out research/investigation and development work to solve practical problems.	**PO 1**
2.	An ability to write and present a substantial technical report/ document.	**PO 2**
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	**PO 3**

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						

Mention the levels: 1, 2, 3						

Scheme of Continuous Internal Evaluation (CIE)

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50**)	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					

Lab component:				
Components	Conduct of the lab	Journal submission	Lab Test	TotalMarks
Lab	10	10	5	25
Total CIE: 50 (T) +25(L) = 75 marks				
Minimum score to be eligible to SEE for this course : 40% in each component				
Not eligible in any one of the component will be considered as NOT eligible for the Course				

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):			
Theory Component:			
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 out of 100**		
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.		
Lab component:			
1.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
2.	It will be conducted for 50 marks having 3 hours/2 hours duration. **It will be reduced to 25 marks for the calculation of SGPA and CGPA.**		
3.	Viva-voce is conducted for individual student.		
Total SEE: 50(T) +25(L) = 75 marks			
Minimum score for passing this course : 40% in each component compulsory			
Not eligible in any one of the component will be considered as NOT eligible for the Course			

Professional Elective – II: Pattern Recognition and Classification

Course Code	20DCN241	**Credits L – T – P**	4 – 0 – 0
Course type	PE – II	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 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 **10 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 **10 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.	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2.	An ability to write and present a substantial technical report/document.	2
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)	CO-PSO Mapping(planned)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
➢ Writing two IA test is compulsory. ➢ **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – II: Optical Networks

Course Code	20DCN242	**Credits L – T – P**	4 – 0 – 0
Course type	PE – II	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

	Program Specific Outcome of this course (PSOs)	PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of	**2**

	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.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	**Target**
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – II: Cyber Physical Systems

Course Code	20DCN243	**Credits L – T – P**	4 – 0 – 0
Course type	PE – II	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 Hours**

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

Unit - III **10 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 **10 Hours**

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

Unit - V **10 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.	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2.	An ability to write and present a substantial technical report/document.	2
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

	Program Specific Outcome of this course (PSOs)	**PSO No.**
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	**Target**
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Black board
2. Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – II: Ad-hoc Networks

Course Code	20DCN244	**Credits L – T – P**	4 – 0 – 0
Course type	PE – II	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 Hours**

WSN–MAC:

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

Unit – IV **10 Hours**

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

Unit – V **10 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.	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2.	An ability to write and present a substantial technical report/document.	2
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

	Program Specific Outcome of this course (PSOs)	**PSO No.**
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	**Target**
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1.Black board

2.Presentation

Assessment methods

1. IA Tests
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50**)	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Error Control Coding

Course Code	20DCN31	**Credits L – T – P**	4 – 0 – 0
Course type	PC1	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 10 Hours

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 10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	

3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Classroom Teaching
2. Presentation
3. Animations
4. Videos

Assessment methods

1. Internal Assessment Tests
2. Assignments
3. Seminar
4. IEEE paper implementation

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Advances in Antenna and Microwave Engineering (Integrated)

Course Code	**20DCN32**	**Credits L – T – P**	3 – 0 – 1
Course type	PC2	**Total credits**	4
Hours/week: L-T-P	3 – 0 - 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = Hrs; P = 24Hrs Total = 64 Hrs	**SEE Marks**	50(T)+25(L) = 75 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 8 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 8 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 8 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 8 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 **8 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).

Unit – VI		**7 Hours**
List of experiments		
1.	Simulation of N element linear array	
2.	Simulation of NxN planar arrays	
3.	Antenna array synthesis using Delph Chebyshev method	
4.	Design and simulation of different antennas using numerical solver tool	

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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Blackboard Teaching
2. Presentations

Assessment methods

1. Internal Assessment
2. Assignment
3. Activity

Scheme of Continuous Internal Evaluation (CIE)

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					

Lab component:				
Components	Conduct of the lab	Journal submission	Lab Test	Total Marks
Lab	10	10	5	25
Total CIE: 50 (T) +25(L) = 75 marks				
Minimum score to be eligible to SEE for this course: 40% in each component				
Not eligible in any one of the components will be considered as NOT eligible for the Course				

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):			
Theory Component:			
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 out of 100**		
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.		
Lab component:			
1.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
2.	It will be conducted for 50 marks having 3 hours/2 hours duration. **It will be reduced to 25 marks for the calculation of SGPA and CGPA.**		
3.	Viva-voce is conducted for individual student.		
Total SEE: 50(T) +25(L) = 75 marks			
Minimum score for passing this course: 40% in each component compulsory			
Not eligible in any one of the components will be considered as NOT eligible for the Course			

Adaptive Signal Processing (Integrated)

Course Code	**20DCN33**	**Credits L – T – P**	3 – 0 – 1
Course type	PC3	**Total credits**	4
Hours/week: L-T-P	3 – 0 – 2	**CIE Marks**	50(T)+25(L) = 75 marks
Total Hours:	L = 40 Hrs; T = Hrs; P = 24Hrs Total = 64Hrs	**SEE Marks**	50(T)+25(L) = 75 marks

Course learning objectives	
1.	Understand meaning of "adaption" in terms of signal processing and geometrical terms.
2.	Analyze basic non-recursive adaptive filter, that is, the adaptive linear combiner.
3.	Understand performance or error surface under stationary and non-stationary conditions.
4.	Understand LMS algorithms and other types of adaptive algorithms.
5.	Understand adaptive modelling and system identification; inverse adaptive modelling, deconvolution and equalization.

Pre-requisites: Signals and Systems, Digital Signal Processing,

Unit - I	**8 Hours**
Adaptive systems: Definitions and characteristics - applications - properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction – linear optimum filtering-orthogonality – WienerHopf equation- Performance Surface. (Text 1)	

Unit - II	**8 Hours**
Searching performance surface-stability and rate of convergence: learning curve-gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty - variance - excess MSE and time constants – misadjustments. (Text 1)	

Unit - III	**8 Hours**
LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm – adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals. (Text 1)	

Unit - IV	**8 Hours**
Applications-adaptive modeling: Multipath communication channel, geophysical exploration, FIR digital filter synthesis. (Text 2)	

Unit - V	**8 Hours**
System identification-adaptive modeling: Inverse adaptive modeling, equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis. (Text 2)	

Unit – VI	**____ Hours**
List of experiments	
	Design and analyze the adaptive filters for following applications: a. System identification b. Linear prediction c. Inverse modelling d. Jammer suppression e. Adaptive notch filtering **f.** Noise calncellation

Books	
	Text Books:
1.	Simon Haykin, **"Adaptive Filter Theory"**, Pearson Education, 2003.
2.	Bernard Widrow and Samuel D. Stearns, **"Adaptive Signal Processing"**, Person Education, 2005.
	Reference Books:
1.	John R.Treichler, C.Richard Johnson, Michael G.Larimore, **"Theory and Design of Adaptive Filters"**, Prentice-Hall of India,2002
2.	S.Thomas Alexander, "Adaptive Signal Processing-Theory and Application", Springer-Verlag.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	
2.	

Course delivery methods

1. Blackboard Teaching
2. Presentations

Assessment methods

1. Internal Assessment
2. Assignment
3. Activity

Course Outcome (COs)		
At the end of the course, the student will be able to		Bloom's Level
1.	Design optimal minimum mean square estimators and in particular linear estimators.	L3
2.	Implement adaptive filters (FIR, IIR, non-causal, causal) and evaluate their performance.	L3
3.	Identify applications in which it would be possible to use the different adaptive filtering approaches.	L4

Program Outcome of this course (POs) **PO No.**

1. An ability to independently carry out research /investigation and development work to solve practical problems. 1
2. An ability to write and present a substantial technical report/document. 2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. 3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**

2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Scheme of Continuous Internal Evaluation (CIE)

Theory Component:					
Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
■ 100 marks will be reduced to 50 marks for the calculation of SGPA and CGPA.					
Lab component:					
Components	Conduct of the lab	Journal submission	Lab Test	Total Marks	
Lab	10	10	5	25	
Total CIE: 50 (T) +25(L) = 75 marks					
Minimum score to be eligible to SEE for this course: 40% in each component					
Not eligible in any one of the components will be considered as NOT eligible for the Course					

Scheme of Semester End Examination (SEE)

Scheme of Semester End Examination (SEE):			
Theory Component:			
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 out of 100**		
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.		
Lab component:			
1.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
2.	It will be conducted for 50 marks having 3 hours/2 hours duration. **It will be reduced to 25 marks for the calculation of SGPA and CGPA.**		
3.	Viva-voce is conducted for individual student.		

Total SEE: 50(T) +25(L) = 75 marks
Minimum score for passing this course: 40% in each component compulsory
Not eligible in any one of the components will be considered as NOT eligible for the Course

Professional Elective – III: High Performance Computing

Course Code	20DCN341	**Credits L – T – P**	4 – 0 – 0
Course type	PE – III	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 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 **10 Hours**

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

Unit – V **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of	**2**

	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.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	**Target**
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

1. Blackboard Teaching
2. Presentation and Simulation
3. Videos

Assessment methods

1. Internal Assessment
2. Case Study
3. Assignment

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – III: Human Computer Interaction

Course Code	20DCN342	**Credits L – T – P**	4 – 0 – 0
Course type	PE – III	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

	Program Specific Outcome of this course (PSOs)	PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

Course delivery methods

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

Assessment methods

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

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – III: CMOS RF Circuit Design

Course Code	20DCN343	**Credits L – T – P**	4 – 0 – 0
Course type	PE – III	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 **10 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 **10 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 **10 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 **10 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 **10 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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target

1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				**CO-PSO Mapping(planned)**		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50**)	50

- Writing two IA test is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Professional Elective – III: Real Time Systems

Course Code	20DCN344	**Credits L – T – P**	4 – 0 – 0
Course type	PE – III	**Total credits**	4
Hours/week: L-T-P	4 – 0 – 0	**CIE Marks**	50
Total Hours:	50	**SEE Marks**	50

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 10 Hours

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 10 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 10 Hours

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 10 Hours

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 10 Hours

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. An ability to independently carry out research /investigation and development work to solve practical problems.	1
2. An ability to write and present a substantial technical report/document.	2
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3

Program Specific Outcome of this course (PSOs)		PSO No.
1.	Understanding and applying the mathematical and scientific concepts, for analysis and design of Communication and Networking systems.	**1**
2.	Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.	**2**
3.	Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.	**3**

Mapping through Direct Assessment:

Rubrics:

Levels	Target
1	**50 % of the total marks is scored by 60% of the students. (It is example)**
2	
3	

CO-PO Mapping (planned)				CO-PSO Mapping(planned)		
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1						
CO2						
CO3						
Mention the levels: 1, 2, 3						

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	Addition of two IA tests	Addition of two assignments	Seminar/ Mini Project	Total Marks	Final marks
Theory	30+30	10+10	20	100 **(reduced to 50)**	50
➢ Writing two IA test is compulsory. ➢ **Minimum marks required to qualify for SEE: 20 out of 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:**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.