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 (1st to 4th Semester) and
1st to 4th Semester Syllabus (2022 Scheme)
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.

2022-23 Scheme of Teaching and Examination

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

Total credits for M. Tech. Program: 80

	Semester	Credits per Sem	Total credits
1st year	1	22	40
	2	18	
2nd year	3	22	40
	4	18	
	Total	**80**	**80**

Curriculum frame work:

Sl. No.	Course		Credits
1	Basic Science Courses	BSC	03
2	Professional Core Courses	PCC	29
3	Professional Elective Courses	PEC	09
5	Open Elective Courses	OEC	03
6	Internship	INT	06
7	Minor with seminar	MPS	03
8	Societal project	SP	03
9	Major project	PROJ	21
10	Research methodology and IPR	MCC	03
	Total		80

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		

I SEMESTER											
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours per Week**			**Examination**				**Credits**
				Theory	**Tutorial/ Skill Development Activities**	**Practical /Seminar**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
				L	**T/SDA**	**P**					
1	BSC	22DCN11	Advanced Engineering Mathematics	3	0	0	03	100	100	200	3
2	IPCC	22DCN12	Advanced Digital Signal Processing	3	0	2	03	100	100	200	4
3	PCC	22DCN13	Advanced Communication Networks	4	0	0	03	100	100	200	4
4	PCC	22DCN14	Wireless Communication	3	0	0	03	100	100	200	3
5	PCC	22DCN15	Advanced Embedded System	3	0	0	03	100	100	200	3
6	MCC	22DCN16	Research Methodology and IPR	3	0	0	03	100	100	200	3
7	PCCL	22DCNL17	Communication Networks Laboratory	0	0	4	03	100	100	200	2
TOTAL				**19**	**0**	**06**	**21**	**700**	**700**	**1400**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course,
AUD/AEC –Audit Course / Ability Enhancement Course (A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students)

II SEMESTER											
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours per Week**			**Examination**				**Credits**
				Theory	**Tutorial/ Skill Development Activities**	**Practical/ Seminar**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
				L	**T/SDA**	**P**					
1	PCC	22DCN21	Advanced Digital Communication	3	0	0	03	100	100	200	3
2	IPCC	22DCN22	Antenna Theory and Design	3	0	2	03	100	100	200	4
3	PEC	22DCN23x	Professional elective 1	3	0	0	03	100	100	200	3
4	PEC	22DCN24x	Professional elective 2	3	0	0	03	100	100	200	3
5	MPS	22DCN25	Mini Project with Seminar	0	2	4	--	100	--	100	3
6	PCCL	22DCNL26	Advanced Communication laboratory	0	0	4	03	100	100	200	2
TOTAL				**12**	**2**	**10**	**15**	**600**	**500**	**1100**	**18**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project with Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab,
L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students)

Professional Elective 1		**Professional Elective 2**	
Course Code under 22DCN23X	**Course title**	**Course Code under 22DCN24X**	**Course title**
22DCN231	Soft Computing	22DCN241	Pattern Recognition and Classification
22DCN232	Advanced Multimedia Communication	22DCN242	Cyber Physical System
22DCN233	Information Security	22DCN243	Optical Networks
22DCN234	Modelling Simulation and Analysis of Systems	22DCN244	Statistical Signal Processing

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Tutorial/ Skill Development Activities	Practical/ Seminar	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T/SDA	P					
1	IPCC	22DCN31	Adaptive Signal Processing	3	0	2	03	100	100	200	4
2	PEC	22DCN32X	Professional elective 3	3	0	0	03	100	100	200	3
3	OEC	22DCN33X	Open elective Courses-1	3	0	0	03	100	100	200	3
4	PROJ	22DCN34	Project Work phase -1	0	0	6	--	100	--	100	3
5	SP	22DCN35	Societal Project	0	2	4	--	100	--	100	3
6	AUD	22DCN36	BOS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**9**	**2**	**12**	**09**	**500**	**300**	**800**	**16**

***Project based learning (PBL) course with 2-0-2 LTP structure.**

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

Minimum of 50 papers should be referred to carry out the literature review. ***Prior art search should be included*** in the thesis. The literature review should result in a technical paper (preferably). Since the problem statement is defined at the end of the literature review, ***students are not allowed to change the project title/work in the 4th semester.***

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.
Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

Professional elective 3		**Open elective 1**	
Course Code under 22DCN32X	**Course title**	**Course Code under 22DCN33X**	**Course title**
22DCN321	Software Defined Networks	22DCN331	Real Time Systems
22DCN322	RF and Microwave Circuit Design	22DCN332	MEMS and Sensors
22DCN323	Software Defined Radio*	22DCN333	Modelling Simulation and Analysis of Physical Systems
22DCN324	Error Control Coding	22DCN334	Internet of Things and Industrial Applications

***Project based learning (PBL) course with 2-0-2 LTP structure.**

IV SEMESTER										
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours /Week**		**Examination**				**Credits**
				Theory	**Practical/ Field work**	**Duration in hours**	**CIE Marks**	**SEE Marks Viva voce**	**Total Marks**	
				L	**P**					
1	Project	22DCN41	Project work phase -2	--	08	03	100	100	200	18
2	INT	22DCNI42	Internship	06 weeks internship (to be completed after III semester.)		03	100	100	200	6
3	AUD	22DCN42	BOS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.						PP
TOTAL				**--**	**08**	**03**	**200**	**200**	**400**	**24**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

2. Internship: All the students shall have to undergo a mandatory internship of 06 weeks during the IV semester. A University examination shall be conducted during IV semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

Course code	Details
22DCN36/ 22DCN42	The students have to complete the online MOOC courses offered by NPTEL/SWAYAM/NASSCOM of **minimum 8 weeks duration** specified by the department and submit the certificate of completion. The list of courses will be given by PG coordinator depending on the availability.

ADVANCED ENGINEERING MATHEMATICS

Course Code	**22DCN11**	**Course type**	**BSC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	0 Hours			**SEE Marks**	100

Course learning objectives	
1.	To introduce the basic concepts of linear algebra such as RREF, linear independence and linear transformations.
2.	To explore the concepts of vector spaces, dimension of vector space, rank and change of basis.
3.	To understand the orthogonality of vectors and matrix factorization techniques.
4.	To introduce the probability theory concepts.

Pre-requisites: Engineering Mathematics.

Unit – I	**Contact Hours = 8 Hours**
Fundamentals of Linear Algebra Systems of Linear Equations, Row Reduction and Echelon Forms (RREF), Vector equations, Matrix equations, solution sets of linear systems, Applications of linear systems, Linear Independence, Linear Transformation.	
Case Study: DFT as a linear Transformation.	

Unit – II	**Contact Hours = 8 Hours**
Matrix operations, Matrix inversion, Characterization of invertible matrices, Subspaces of $\mathcal{R}^n$,(Null Space, Column Space, Basis of a subspace), Dimension and rank. Vector Spaces and Subspaces, Null Spaces, Column Spaces, and Linear Transformations, Linearly Independent Sets; Bases, Coordinate Systems, The Dimension of a Vector Space, Rank and change of basis.	
Case Study: Fourier Transforms as change of basis.	

Unit – III	**Contact Hours = 8 Hours**
Eigen values and Eigen vectors, Inner Product, Length and Orthogonality, Orthogonal Sets, Orthogonal Projections, Gram-Schmidt Process, Least Squares Problems, Inner Product Spaces. Diagonalization of Symmetric Matrices, Quadratic forms, Constrained Optimization and SVD.	
Case Study: Orthogonal Frequency Division Multiplexing (OFDM) system SVD based image reconstruction	

Unit – IV	**Contact Hours = 8 Hours**
Probability Theory:- Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions illustrations. Poisson, Gaussian and Erlang distributions-examples.	
Case Study: Gaussian Mixture Models	

Unit – V	Contact Hours = 8 Hours
Engineering Applications on Random Processes: - Classification. Stationary, WSS and ergodic random process. Autocorrelation function-properties, Gaussian random process.	
Case Study: Optimum filtering Weiner Filtering.	

Self-Study: After the end of each unit, the students have to review minimum two research papers on any topic covered in the unit and submit the report.

Books	
	Text Books:
1.	David C. Lay, "Linear Algebra and its Applications," 6th edition, Pearson Education (Asia) Pvt. Ltd, 2021.
2.	S. L. Miller and D. C. Childers, "Probability and Random Processes with Application to Signal Processing and Communication", 2nd edition, Academic Press/ Elsevier 2012 and onwards
	Reference Books:
1.	Gilbert Strang, "Linear Algebra and its Applications," 5th edition, Thomson Learning Asia, 2016 onwards.
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.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Prof. Aditya K. Jagannatham, Applied Linear Algebra for Signal Processing, Data Analytics and Machine Learning, IIT Kanpur, url:https://nptel.ac.in/courses/108104174

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
		3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the advanced concepts in linear algebra and probability theory.	Un	3	1
2.	Apply probability theory and linear algebra to model and solve dynamic systems.	Ap	3	1
3.	Analyze the given system using linear algebraic and probabilistic tools.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO 1**	**PSO 2**	**PSO 3**
1			✓	✓		
2			✓	✓		
3	✓		✓	✓	✓	
Tick mark the CO, PO and PSO mapping						

ADVANCED DIGITAL SIGNAL PROCESSING (INTEGRATED)

Course Code	**22DCN12**	**Course type**	**IPCC**	**Credits L-T-P**	3 - 0 - 1
Hours/week: L - T- P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
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.

Required Knowledge of: Digital Signal Processing

Unit – I	**Contact Hours = 8 Hours**
Review of Spectral Analysis of Discrete time Signals and Systems: **Review of Transforms:** DTFT, Z transforms, DFT computation using FFT. **Introduction to 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	**Contact Hours = 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:** State space realization of IIR and FIR filters.	

Unit – III	**Contact Hours = 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	**Contact Hours = 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	**Contact Hours = 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.

S. No.	List of Experiments
1.	Design and synthesis of Digital IIR filters: a. LPF b. HPF
2.	Design and synthesis of Digital FIR filters. a. LPF b. HPF
3.	Simulation of Up sampler.
4.	Simulation of down sampler.
5.	QMF Filter design.
6.	Study of FFT analyzer for given application.
7.	Demonstration of Adaptive Sub Band Speech Coding (ASBC)
8.	Implementation of STFT applied to speech analysis.

Books	
	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 delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Understand and apply suitable multirate signal processing technique for a given application.	Ap	1,3	1,2
2.	Implement transmultiplexers and QMF filter banks for a given application.	Ap	1,3	1,2
3.	Design and implement fixed and multirate filter banks and perform spectral analysis.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester.

The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OA/Lab Project/ Industry assignment/Course Project)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:
1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:
1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)
1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:
1. 50% and above (30 marks and above) in theory component
2. 50% and above (20 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 40% &, however overall score of CIE+SEE should be ≥ 50%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADVANCED COMMUNICATION NETWORKS

Course Code	22DCN13	Course type	PCC	Credits L-T-P	4 – 0 – 0
Hours/week: L - T- P	4 – 0 – 0			Total credits	4
Total Contact Hours	L = 50 Hrs; T = 0 Hrs; P = 0 Hrs Total = 50 Hrs			CIE Marks	100
Flipped Classes content	0 Hours			SEE Marks	100

Course learning objectives	
1.	To overview depth in computer communication systems and networks topics that may have been covered at undergraduate level.
2.	To introduce students to some of the latest systems and technologies, and how they are used today.
3.	To discuss some of the key emerging systems and technologies, including research issues and challenges, and their impact on current and future systems.
4.	To understand the impact of block chain technology and software defined networking in computer communication.

Pre-requisites: Digital Communication, Information theory coding.

Unit – I	Contact Hours = 10 Hours
Foundation: Overview Of Communication Networks And Internet, Nuts And Bolts Description, Services Description, Protocol Description, Network Edge, Access Networks, Network Core, Performance Parameters, Layered Architecture, Delay Tolerant Networks. **Case study:** Implementing Network Software, IEEE 802.3 and 802.11 standards.	

Unit – II	Contact Hours = 10 Hours
Internetworking-I: Reliable Transmission, Stop-and-Wait, Sliding Window, Switching and Forwarding, Virtual Circuit Switching, Source Routing. **Internetworking-II**: Datagram Forwarding in IP, IP addressing, IPv6, Datagram Fragmentation and Delays, ARP configuration, Numerical relevant to the topic. **Case study:** Subnetting, Error Reporting (ICMP), Virtual Networks and Tunnels.	

Unit – III	Contact Hours = 10 Hours
Resource Allocation in Networks: Challenges, Taxonomy, Mismatch Multi Link Model And Evaluation Criteria. Quality Of Service, Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF), Equation-Based Traffic Control. **Networks Attacks**: Types, Firewall, Zone Based Firewall, Firewall Methodologies, HTTP Non-Persistent & Persistent Connection. **Case study:** LZW (Lempel–Ziv–Welch) Compression technique. RC4 and RC5 Encryption Algorithm.	

Unit – IV	Contact Hours = 10 Hours
Switches and Control Planes: Evolution of Switches And Control Planes, Cost, SDN Implications For Research And Innovation, Data Center Innovation, Data Center Needs. **Software Defined Networking**: Abstract, Fundamental Characteristics of SDN, SDN operation, SDN Devices, SDN Controller, SDN Applications.	

Unit – V	Contact Hours = 10 Hours
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. **Case study:** Uses of Block chain for Network Engineers.	

Books	
	Text Books:
1.	Larry Peterson and Bruce S Davis, "Computer Networks: A System Approach" 5th Edition, Elsevier, 2014.
2.	Computer Networking: A Top-Down Approach Hardcover – by Kurose Ross. Student Edition, 26 April 2016.
3.	Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2nd edition, 2010.
	Reference Books
1.	Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" , Morgan Kaufman Publishers, 2004
2.	Manav Gupta, Blockchain For Dummies, IBM Limited Edition, John Wiley & Sons, Inc.
	E- Resource
1.	https://www.blockchain-council.org/blockchain/uses-of-blockchain-for-network-engineers/
2.	Habib, G.; Sharma, S.; Ibrahim, S.; Ahmad, I.; Qureshi, S.; Ishfaq, M. Blockchain Technology: Benefits, Challenges, Applications, and Integration of Blockchain Technology with Cloud Computing. *Future Internet* 2022, *14*, 341. https://doi.org/10.3390/fi14110341

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Identify and explain current technology trends for the implementation and deployment of communication network.	L2	1,2	1
2.	Design and develop protocols for reliable communication Networks	L3	1,2	1
3.	Design a network with appropriate protocols selected according to performance requirement.	L4	2,3	2
4.	Optimize the Network Design with use of block chain technology and software defined network.	L4	2,3	2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓	✓		✓		
2	✓	✓		✓		
3		✓	✓		✓	
4		✓	✓		✓	
Tick mark (✓) the CO, PO and PSO mapping						

WIRELESS COMMUNICATION

Course Code	**22DCN14**	**Course type**	**PCC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To enable the student to understand the cellular concept and system design fundamentals
2.	To enable the student to analyze large scale path loss
3.	To enable the student to analyze small scale fading and multipath
4.	To enable the student to choose different modulation techniques for wireless communication
5.	To enable the student to understand advanced wireless communication techniques

Pre-requisites : : 1. Analog Communication
2. Digital Communication

Unit – I	**Contact Hours = 8 Hours**
The Cellular Concept- System Design Fundamentals Introduction, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems.	

Unit – II	**Contact Hours = 8 Hours**
Wireless Signal Propagation: Large Scale Path Loss Introduction, Free-space propagation model, Relating power to electric field, The three propagation mechanisms- Reflection, Diffraction, Scattering, Outdoor propagation models, Indoor propagation models.	

Unit – III	**Contact Hours = 8 Hours**
Wireless Signal Propagation: Small-scale Fading and Multipath Small-scale multipath propagation, Impulse response model of a multipath channel, Small-scale multipath measurements, Parameters of mobile multipath channels, Types of small-scale fading, Rayleigh and Ricean distributions, Statistical models for multipath fading channels.	

Unit – IV	**Contact Hours = 8 Hours**
Modulation Techniques for Wireless Communication Linear modulation techniques, Constant envelope modulation, Combined linear and constant envelope modulation, Spread spectrum modulation techniques, Multiple Access Techniques.	

Unit – V	**Contact Hours = 8 Hours**
Advanced Wireless Communication Techniques Introduction to MIMO, OFDM, Wi-MAX, 4G-LTE, 5G – Basic concepts, types, advantages, disadvantages, applications.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Theodore S. Rappaport, Wireless Communications- Principles and Practice, Pearson, 2nd Ed, 2010.
2.	Dr. Kamilo Feher, Wireless Digital Communications, PHI, 4th Ed, 2010.
	Reference Books:
1.	Jochen Schiller, Mobile Communications, Pearson Education, 2nd Ed, 2004.
2.	Vijay K. Garg, Wireless Communications and Networking, Elsevier, 1st Ed, 2008.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the cellular concept and system design fundamentals	Un	3	1,2
2.	**Analyze** large scale path loss in wireless communication channel	An	3	1,2
3.	**Analyze** small scale fading and multipath in wireless communication channel	An	3	1,2
4.	**Choose** different modulation techniques for given applications in wireless communication	Ap	1,3	1,2
5.	**Understand** advanced wireless communication techniques	Un	3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓	✓	✓	
2			✓	✓	✓	
3			✓	✓	✓	
4	✓		✓	✓	✓	
5			✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADVANCED EMBEDDED SYSTEM

Course Code	22DCN15	Course type	PCC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To gain knowledge about ARM Cortex M series, popularly used in embedded systems as processing unit and other Embedded processors.
2.	To study the hardware modules and software tools used in programming an embedded system
3.	To study about device drivers needed for embedded systems and Real time communication
4.	To study application areas of Embedded Systems

Pre-requisites: Microcontrollers

Unit – I	Contact Hours = 8 Hours
Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Sensors, Actuators, Communication Interface. **ARM-32 bit Microcontroller:** Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence	

Unit – II	Contact Hours = 8 Hours
Hardware Modules: Introduction: MC9S12XD family features, Modes of operation, functional block diagram, overview, programming model. Memory Map Overview of Pulse Width Modulator (PWM), On-chip ADC, Serial Communication. Memory Map Overview of Serial Communication Interface (SCI), Serial Peripheral Interface (SPI), Inter-Integrated Circuit (IIC), Controller Area Network (CAN) **Case Study:** Code warrior IDE	

Unit – III	Contact Hours = 8 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.	

Unit – IV	Contact Hours = 8 Hours
Linux Fundamentals & Device Driver Programming Linux Fundamentals, Linux Commands, VI Editors, Introduction to Device Driver, The Role of Device Driver, Kernel Module Vs Application, Types of Device Driver, Character Driver, Block Driver & Network Driver	

Unit – V	Contact Hours = 8 Hours
Embedded System Applications: Design multitasking Embedded System to simulate ATM machines, mirrors and sun-roofs, Central locking and Electric windows, Cruise control, Multimedia over IP, Airbags, Safety critical systems, Battery operated smartcard reader, Automated meter reading system **Design Case Studies**: Prototype model of Dashboard, Lighting system, Power window prototype and Sun roof control using DC Motor, Climate control system prototype using temperature sensor.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008**.**
2.	ARM System on Chip Architecture by Steve Furber, Pearson Education.
3.	David E. Simon An Embedded Software Primer, Pearson Education
4.	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009 and onwards.
5.	Raj Kamal, "Embedded Systems Architecture, programming and design", TMH, 2nd Edition, 2008
6.	Application module student learning kit featuring freescale MC9S12XDT512.
7.	CodeWarrior Debugger IDE, NXP semiconductors.
8.	Ross Dickson, Jason Andrews, Jacob Engblom, "Design Flow for Embedded System Device Driver Development and Verification".
9.	Michael Opdenacker, "Embedded Linux kernel and driver development".
10.	Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
11.	Krishna and Shin, "Real-Time Systems," Tata McGraw Hill. 1999.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	**Understand** the importance of embedded systems in real life.	Un	1	2
2.	**Anlayze** the importance of cortex M series compared to other series in embedded systems	Ap	2	2
3.	**Design and implement** the concepts of Hardware-Software co-	An	1,3	1,2

	design to design an Embedded System.			
4.	**Apply** the knowledge of device drivers for development of embedded systems	Ap	2	2
5.	**Design** and simulate embedded systems for different application domains	Cr	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓				✓	
2		✓			✓	
3	✓		✓	✓	✓	
4		✓			✓	
5	✓		✓	✓	✓	✓
Tick mark (✓) the CO, PO and PSO mapping						

RESEARCH METHODOLOGY AND IPR

Course Code	22DCN16	**Course type**	MCC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40Hrs; T = 00 Hrs;P = 00Hrs Total = 40Hrs			**CIE Marks**	100
Flipped Classes content	00 Hrs			**SEE Marks**	100

Course learning Objectives	
1.	Understand the basic concepts of research and its methodologies
2.	Identify and select the appropriate research/sampling design methods.
3.	Analyze and interpret the data to enable hypothesis testing
4.	CreatetheawarenessaboutIntellectualPropertyRightsfortheprotectionofinventions.

Pre-requisites: Probability &Statistics

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,

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,. **Chi-square test: χ2** 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.	

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, Plagiarism, Prior art search. **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, Mechanics of writing research report.	

Self-Study Topics	
UnitNo.	**Topic description**
I	Significance of Research Methodology.
II	Implications of a sample design.
III	Other measures-Index numbers, Time series analysis.
IV	Limitations of test of hypothesis.
V	Precautions for writing research reports.

Books	
	Text Books:
1.	C R. Kothari, Research Methodology, New Age International Publishers, 2nd edition, 2007.
	Reference Books:
1.	Panneer Selvam, Research Methodology, PHI Learning Pvt. Ltd., 2007.
2.	Dr. B.L. Wadhera -Intellectual Property Rights, Universal Law Publishing Co. Ltd.. 2002
	William G Zikmund, Business Research Methods, Indian edition, South western Publishers, 8th Indian Reprint – 2009.
	E-resourses (NPTEL/SWAYAM. Any Other)- mention links
1.	https://onlinecourses.swayam2.ac.in/cec20_ge37 (Research Methodology)

Course delivery methods		Assessment methods	
1.	Lecture and Board	1.	Assignments and Open Book Assignments
2.	NPTEL/ Edusat	2.	Quizzes
3.	PowerPoint Presentation	3.	Internal Assessment Tests
4.	Videos	4.	Semester End Examination

Course Outcome (COs) **Learning Levels:** **Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create**				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Identify and select an appropriate methodology for research.	Re	1	1
2.	Design and Apply suitable research/sampling procedure for the research problem.	Ap	1	1
3.	Analyze and interpret data collected & Evaluate various approaches for hypothesis testing.	An	1,2,3	1,2,3
4.	Discuss the significance of Intellectual Property Rights & report writing	Ev	1,2,3	2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Addition of two OBAs	Course Seminar	Total Marks
Marks	30+30= 60	10+10 =20	20	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping(Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✔			✔		
2	✔			✔		
3	✔	✔	✔	✔	✔	✔
4	✔	✔	✔		✔	✔
Tick mark the CO, PO and PSO mapping						

COMMUNICATION NETWORKS LABORATORY

Course Code	22DCNL17	**Course type**	PCCL	**Credits L-T-P**	0 – 0 – 2
Hours/week: L-T-P	0 – 0 – 4			**Total credits**	2
Total Contact Hours	L = 0 Hrs; T = 0 Hrs; P = 48 Hrs Total = 48 Hrs			**CIE Marks**	100
				SEE Marks	100

Course learning objectives	
1.	To understand the working principle of various communication protocols.
2.	To analyze the various routing algorithms.
3.	To know the concept of data transfer between nodes.
4.	To design small enterprise networks

Required Knowledge of: Communication Engineering, Computer communication

Topics to be covered	**Contact Hours = 10 Hours**
Types of networks: LAN, WAN, MAN and PAN. IP addressing, Introduction to NS2. Need to go for ns2 simulation, Sample code for ns2 basics. Installation and introduction of simulation tool packet tracer. Object explore, Node Configuration, interface types, channel selection, IP configuration. Introduction to Wire shark, Packet Capturing and Analyzing, Data packets on Wire shark, Wire shark filters.	
Orientation session on open ended experiment and course project	**Contact Hours = 02 Hours**

List of Experiments

No. of Experiments	Topic(s) related to Experiment
	The following experiments shall be conducted using NS2/ NS3 Network Simulator
1.	Simulate a point-to-point network with N nodes and duplex links between them.
2.	Implement extended service set in multiple node communication scenarios and determine the performance of the network with respect to transmission of packets.
3.	Implement an enterprise network using N nodes and plot the congestion window.
4.	Simulate mobile network with wireless LAN.
5.	Implement network of N nodes with random delay and bandwidth. Using drop tail queue of 10, show the packet flow under i) Simplex link ii) Duplex links
	The following experiments shall be conducted using wireshark/ Packet Tracer (analyzer tool/configure tool)
6.	Simulation of home/office LAN network using N nodes.
7.	Design and Simulate the DHCP server configuration.
8.	Design and simulate the IOT home automation application.
9.	Simulate the soil sensing and control using IOT application.
10.	Implement and simulate the Routing Information Protocol.
11.	Implement and simulate the Border gateway routing protocol.
12.	Open ended experiment: Implementation of Information exchange between moving vehicles.

Books	
	Text Books:
1.	Larry Peterson and Bruce S Davis, "Computer Networks: A System Approach" 5th Edition, Elsevier, 2014.
	E-resourses (NPTEL/SWAYAM. Any Other)- mention links
1.	https://onl.kmi.open.ac.uk/
2.	https://www.wireshark.org/
3.	https://www.isi.edu/nsnam/ns/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)				
Learning Levels: **Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create**				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Evaluate the performance of computer networks with n nodes.	Ev	1,3	2
2.	Identify and explain current technology trends for the implementation and deployment of wireless network routing.	Ap	1,3	2
3.	Design a network with appropriate protocols selected according to requirement.	An	1,2	2
4.	Analyze performance of various communication protocols.	An	1,2	2

Lab CIE:

IA	**Journal submission**	**Conduction and Viva**	**Course Project**
25	25	20+10	20
IA Test: 1. No objective part in IA question paper 2. All questions are experiments.			
Conduct of Lab: 1. Lab IA: 25 marks 2. Lab Journal: 25 marks 3. Daily lab execution and viva (average): 30 marks 4. Submission of course project: 20 marks			
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Conducting the experiment and writing report: 5 marks 3. Calculations, results, graph and conclusion: 10 marks 4. Viva voce: 10 marks			
Eligibility for SEE: 1. 50% and above (50 marks and above)			

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Two questions will be asked and student should execute both. Exam includes quiz and viva voce.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓		✓	
2	✓		✓		✓	
3	✓	✓			✓	
4	✓	✓			✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADVANCED DIGITAL COMMUNICATION

Course Code	22DCN21	**Course type**	PCC	**Credits L-T-P**	3 – 0 – 0
Hours/week: L-T-P	3– 0– 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10Hrs			**SEE Marks**	100

Course Learning Objectives (CLOs)	
1.	Understand the mathematical modeling of wired and wireless channels, I-Q modulation and demodulation principles,Bit and carrier Synchronization.
2.	To Study Equalization Techniques and types of adaptive equalizers used in Digital communication systems.
3.	To know the importance of Block and Convolutional coded communication systems.
4.	To Study the principles of Multicarrier Modulation systems.
5.	To know the importance and future of Semantic Communications.

Pre-requisites: Digital Communication and Information Theory.

Unit – I	**8 Hours**
Introduction mathematical models for communication channel: Communication channels and their characteristics, Mathematical models for communication channels. Introduction to Wireless channels Rayleigh and Rician channels, Mathematical models for wireless channels, Coherent and noncoherent communication systems, Carrier Synchronization-Bit synchronization. M^{th} power loop, I-Q modulation and demodulation, Importance of I-Q Carriers in digital communication.	

Unit – II	**8 Hours**
Equalization Techniques: Why Equalizers are used in Communication, Types of Equalizers used in Digital communication, Linear Equalizer-Decision feedback equalization-Adaptive Equalization and Adaptive Equalization Algorithms. Self-recovering (Blind)equalizers. Block diagram of different types of adaptive Equalizers and their working.	

Unit – III	**8 Hours**
Block and Convolutional Coded Digital Communication: Architecture and performance–Binary block codes; Modified Linear Block codes, Orthogonal; Biorthogonal; Trans orthogonal–Shannon's channel coding theorem; Channel capacity, Linear block codes; Reed-Muller codes – Space time block codes. Convolutional codes Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram. Decoding techniques using Maximum likelihood, Viterbi algorithm, Turbo Coding.	

Unit – IV	8 Hours
Multichannel, Multicarrier and OFDM Systems: Multichannel Digital Communications in AWGN Channels**,** Binary Signals, M-ary Orthogonal Signals, Single -Carrier verses Multicarrier Modulation, OFDM, Modulation and Demodulation in an OFDM System, An FFT Algorithm Implementation of an OFDM system, Generation of sub-carriers using the IFFT algorithm.	

Unit – V	8 Hours
Introduction to Semantic Communication: A 3-Level communication Model**,** Semantic Information source and Destination, Principles and challenges, Semantic Communication system for object recognition, Comparison of conventional and Semantic communication systems, Semantic Channel and Semantic Channel Capacity, Semantic Rate distortion and Information Bottleneck, The main components in a Semantic Communication system, Semantic OSI model, Semantic Noise, Text Semantic Similarity, Image Semantic Similarity, Speech Quality Measurement, Deep Learning Based Image compression, Semantic Communications for image/video transmission.	

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	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.
3.	IEEE Transactions on Semantic Communications.
	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 delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)				
Learning Levels: **Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create**				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand and apply mathematical modelling of channels and equalization techniques.	Ap	1,3	1,2
2.	Apply various channel coding and multicarrier modulation techniques for effective utilization communication resources like bandwidth and power.	Ap	1, 3	1,2
3.	Understand the limitations of existing digital communication systems and apply semantic communication techniques for error free and effective data transmission.	Ap	1, 3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ANTENNA THEORY AND DESIGN

Course Code	22DCN22	Course type	IPCC	Credits L-T-P	3 – 0 – 2
Hours/week: L - T- P	3 – 0 – 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	Nil			SEE Marks	100

Course learning objectives	
1.	To introduce important parameters of antenna and develop EM equations of dipole and loop.
2.	To explore the arrays of antenna and array synthesis techniques.
3.	To understand the operation of resonant and antennas and broadband antennas.
4.	To introduce aperture antennas and computational electromagnetic techniques applied to antennas.

Pre-requisites: Antenna basics

Unit – I	Contact Hours = 8 Hours
Definition and significance of important antenna parameters – Antenna, Isotropic antenna, practical antenna, beam width, Directive gain and power gain, radiation resistance, antenna aperture, near and far field regions and polarization. Derivation of EM field components of infinitesimal dipole and small loop antenna. Comparison of field patterns, radiation resistance and directivity of dipole and loop antennas.	

Unit – II	Contact Hours = 8 Hours
Arrays: Array factor for linear arrays, uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Nonuniformly excited equally spaced linear arrays, Mutual coupling. **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.	
Self-study: Use of antenna arrays in practical applications – Rhombic array, Multiple Unit Steerable Antenna (MUSA).	

Unit – III	Contact Hours = 8 Hours
Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna. **Broadband antennas:** Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.	

Unit – IV	Contact Hours = 8 Hours
Aperture antennas: Techniques for evaluating gain, Reflector antennas- Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.	

Unit – V	Contact Hours = 8 Hours
CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics.	

Lab Experiments:	
1.	Measurement of directivity and gain of microstrip antennas: a. Dipole b. Patch
2.	Design and Simulation of Dipole antenna and measurement of characteristics of the same.
3.	Design and Simulation of Loop antenna and measurement of characteristics of the same.
4.	Design and Simulation of Helical antenna and measurement of characteristics of the same.
5.	Design and Simulation of Patch antenna and measurement of characteristics of the same.
6.	Design and Simulation of N element linear array of dipole and loop – using array factor and principle of pattern multiplication.
7.	Design and Simulation of NxN planar arrays of isotropic point sources.
8.	Antenna array synthesis using Dolph Chebyshev method.
9.	Design and simulation of an antenna for a given application. (open ended)

Books	
	Text Books:
1.	Stutzman and Thiele, 'Antenna Theory and Design', John Wiley, 2nd Edition, 2010
	Reference Books:
1.	C. A. Balanis, 'Antenna Theory Analysis and Design', John Wiley, 2nd Edition, 2007
2.	J. D. Krauss, 'Antennas and Wave Propagation', McGraw Hill TMH, 4th Edition, 2010
3.	A. R. Harish, M. Sachidanada, 'Antennas and propagation', Pearson Education, 2015

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the basic parameters of various types of antennas and computational electromagnetic techniques applied to antennas.	Un	1,3	1
2.	**Design** various antennas for the specified application or for given design constraints.	Ap	1,3	1,2
3.	**Analyze** the designed antenna for various performance parameters.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester.

The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OA/Lab Project/ Industry assignment/Course Project)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:
1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:
1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)
1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:
1. 50% and above (30 marks and above) in theory component
2. 50% and above (20 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 40% &, however overall score of CIE+SEE should be ≥ 50%.
3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)				CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓		✓	✓		
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark the CO, PO and PSO mapping						

SOFT COMPUTING

Course Code	**22DCN231**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	0 Hours			**SEE Marks**	100

Course learning objectives	
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.

Pre-requisites: Linear Algebra and Probability theory.

Unit – I	**Contact Hours = 8 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	**Contact Hours = 8 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	**Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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.	

Books	
	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 delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the pattern recognition techniques and apply to real time applications.	Ap	1,3	1,2
2.	Develop fuzzy and neural network algorithms for pattern recognition applications.	Ap	1,3	1,2
3.	Apply search technique algorithms in optimization of neuro/fuzzy models.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADVANCED MULTIMEDIA COMMUNICATION

Course Code	22DCN232	Course type	PEC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	0 Hours			SEE Marks	100

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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Represent multimedia information by applying various compression techniques.	Ap	1,3	1,2
2.	Apply audio and video compression standards to conserve bandwidth.	Ap	1,3	1,2
3.	Apply virtual reality techniques to multimedia information.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

INFORMATION SECURITY

Course Code	22DCN233	Course type	PEC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	0 Hours			SEE Marks	100

Course learning objectives	
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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 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.	

Books	
	Text Books:
1.	Behrouz A. Fourouzan, "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 delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply the information security concepts for symmetric and asymmetric cryptographic applications.	Ap	1,3	1,2
2.	Apply security algorithms for ensuring data integrity confidentiality and authentication.	Ap	1,3	1,2
3.	Analyse security enhancement in various networks using firewalls and secure coding.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓		
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

MODELLING SIMULATION AND ANALYSIS OF SYSTEMS

Course Code	**22DCN234**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	0 Hours			**SEE Marks**	100

Course learning objectives	
1.	Introduce fundamental concepts in mathematical modelling of a system.
2.	Understand concept of lumped element modelling.
3.	Explore the modeling of first and second order systems.
4.	Analysis of systems in the frequency domain.
5.	Study systems with feedback.

Pre-requisites: Basic knowledge of Engineering Mathematics, Signals and Systems and Control Systems

Unit – I	**Contact Hours = 8 Hours**
Fundamental concepts in mathematical modeling: Abstraction, linearity and superposition, balance and conservation laws and the system, boundary approach.	

Unit – II	**Contact Hours = 8 Hours**
Lumped element modeling: Mechanical Systems-Translational, rotational. Hydraulic systems. Thermal systems. RLC Electrical Systems.	

Unit – III	**Contact Hours = 8 Hours**
Modeling of first order and second order systems: Governing equations for free and forced responses, transient response specifications, experimental determination, Laplace transform.	

Unit – IV	**Contact Hours = 8 Hours**
Time domain, frequency domain and state space: Frequency response of Linear, Time invariant systems, frequency response of first order and second order systems, state space formulations of systems problems relating frequency response to pole location – transient response-poles and frequency response.	

Unit – V	**Contact Hours = 8 Hours**
Feedback systems: Systems with feedback – block diagrams – properties of feedback systems – relative stability-phase and gain margins.	

Books	
	Text Books:
1.	Philip D Cha, James J Rosenberg and Clive L Dym, "Fundamentals of Modeling and Analyzing Engineering Systems", Cambridge University, 2000.
2.	Amalendu Mukherjee, Ranjit Karmakar, "Modeling and Simulation of engineering Systems through Bondgraphs", Narosa, 2000.
	Reference Books:
1.	Close Frederick, "Modeling and Analysis of Dynamic Systems", Wiley.
2.	Woods, Robert L., and Lawrence Kent L, "Modeling and Simulation of Dynamic Systems", Prentice Hall, 1997.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Demonstrating the fundamental concepts of mathematical modelling of physical systems.	Un	1,3	1,2
2.	Application of lumped parameter modelling concepts for first and second order systems.	Ap	1,3	1,2
3.	Application and time frequency analysis of feedback systems with differential equation and state variable modellling.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓		
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

PATTERN RECOGNITION AND CLASSIFICATION

Course Code	**22DCN241**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	0 Hours			**SEE Marks**	100

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	**Contact Hours = 8 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	**Contact Hours = 8 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	**Contact Hours = 8 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	Contact Hours = 8 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	Contact Hours = 8 Hours
Applications of Pattern Recognition: Overview of applications of Pattern Recognition - Text Classification, Image Classification and Speech recognition and classification.	

Books	
	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 delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the role of information as a pattern and apply classification techniques to make decisions.	Ap	1,3	1,2
2.	Apply dimension reduction techniques to reduce feature of any pattern to classify accurately.	Ap	1,3	1,2
3.	Develop mathematical models for pattern analysis and classification.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

CYBER PHYSICAL SYSTEM

Course Code	22DCN242	Course type	PEC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	0 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the concept of cyber physical systems (CPS) and know the fundamentals
2.	research challenges in this area.
3.	Understand the networked interoperability in heterogeneous CPS systems.
4.	Improving critical reading, presentation, and research skills.

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

Unit – I	Contact Hours = 8 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	Contact Hours = 8 Hours
Embedded processors, Types and parallelism, Memory Architecture, Technology Heirarchy and Models.	

Unit – III	Contact Hours = 8 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	Contact Hours = 8 Hours
Invariants and temporal logic, linear temporal logic, equivalence and refinement, Models as specifications, Type equivalence and refinement.	

Unit – V	Contact Hours = 8 Hours
Open and closed systems, Reachability analysis, Abstraction in model checking, Quantitative analysis, Factors determining execution time, Execution time analysis.	

Books	
	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 delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the networked interoperability in heterogeneous CPS.	Un	1,3	1
2.	Appy system-modeling techniques and timed automata to CPS system design.	Ap	1,3	1,2
3.	Analyze hardware and OS capabilities in CPS.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓		
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

OPTICAL NETWORKS

Course Code	**22DCN243**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	0 Hours			**SEE Marks**	100

Course learning objectives	
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.

Pre-requisites: Optic Fiber Communication and Computer Communication Networks

Unit – I	**Contact Hours = 8 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	**Contact Hours = 8 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	**Contact Hours = 8 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	**Contact Hours = 8 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	**Contact Hours = 8 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.	

Books	
	Text Books:
1.	Rajeev Ramaswamy, Kumar N Sivarajan and Galen H Sasaki, “Optical Networks”, Elsevier Publication 3rd Edn. (onwards), 2009.
	Reference Books:
1.	Uyless Black, “Optical Networks-Third generation transport system”, Pearson, 2013 and onwards.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the architecture of SONET/SDH in optical networks.	Un	1,3	1
2.	Apply WDMs in optical network for appropriate utilization of network resources.	Ap	1,3	1,2
3.	Apply secured algorithms to protect data over SONET/SDH optical networks.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓		
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

STATISTICAL SIGNAL PROCESSING

Course Code	22DCN244	Course type	PEC	Credits L-T-P	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	0 Hours			SEE Marks	100

Course learning objectives	
1.	Study the statistical modelling techniques for modelling real-world signals and systems.
2.	Understand the spectrum estimation and optimal filtering techniques.
3.	Study the concepts of adaptive filtering and array processing with applied to real-world signals and systems.

Pre-requisites: Basic knowledge of Advanced Engineering Mathematics, Signals and Systems and Digital Signal Processing is required.

Unit – I	Contact Hours = 8 Hours
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text 1).	

Unit – II	Contact Hours = 8 Hours
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text 1).	

Unit – III	Contact Hours = 8 Hours
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text 1).	

Unit – IV	Contact Hours = 8 Hours
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms (Text 1).	

Unit – V	Contact Hours = 8 Hours
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beamforming, linearly constrained minimum-variance beam-formers, side-lobe cancellers (Text 2).	

Books	
	Text Books:
1.	Monson H Hayes, 'Statistical Digital Signal Processing and Modeling', John Wiley & Sons (Asia) Pvt. Ltd., 2002.
2.	Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, 'Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing', McGraw Hill International Edition, 2000.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply the concepts of random processes for the modelling of signals and systems.	Ap	1,3	1,2
2.	Apply various spectrum estimation techniques for the spectral analysis of real-world signals.	Ap	1,3	1,2
3.	Apply optimal filtering and array processing techniques for analysis of real-world signals.	Ap	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				CO-PSO Mapping (Planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADVANCED COMMUNICATION LABORATORY

Course Code	22DCNL26	Course type	PCCL	Credits L-T-P	0 – 0 – 2
Hours/week: L - T- P	0 – 0 – 4			Total credits	2
Total Contact Hours	L = 0Hrs; T = 0 Hrs; P = 48 Hrs Total = 48 Hrs			CIE Marks	100
Flipped Classes content	Nil			SEE Marks	100

Course learning objectives	
1.	To study the effect of SNR variation on BER.
2.	To study the use of channel equalizers in digital communication.
3.	To know the importance of adaptive signal processing applied to digital communication systems.

Required Knowledge of: Digital Communication, Information Theory and Coding and Digital Signal Processing.

Topics to be covered	Contact Hours = 10 Hours
Review of RF digital modulation techniques – ASK, FSK, PSK and QPSK, effect ISI, Probability of error, Bit error rate. Significance of Signal constellation, Effect of SNR on BER. Introduction to communication tool box and useful commands. Introduction to Rayleigh distribution, Rayleigh channel modelling, Rayleigh fading. Gaussian distribution and AWGN channel Modelling. Introduction to equalizers, adaptive equalizers, types – ZFE and MMSE. Introduction to adaptive signal processing, adaptive systems, basic applications, introduction to LMS algorithm, significance of learning curve.	
Orientation session on open ended experiment and course project	**Contact Hours = 02 Hours**

List of Experiments

Expt. No.	Topic(s) related to Experiment
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 for adaptive filtering applications.

Books	
	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 delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Apply** the various RF digital modulation and equalization techniques.	Ap	1,3	1,2
2.	**Apply** LMS algorithms for adaptive filtering applications.	Ap	1,3	1,2
3.	**Analyze** channel performance in terms of SNR and BER variation.	An	1,3	1,2

Scheme of Continuous Internal Evaluation (CIE):

Lab CIE:

IA	**Journal submission**	**Conduction and Viva**	**Course Project**
25	25	20+10	20
IA Test: 1. No objective part in IA question paper 2. All questions are experiments.			
Conduct of Lab:			

1. Lab IA: 25 marks 2. Lab Journal: 25 marks 3. Daily lab execution and viva (average): 30 marks 4. Submission of course project: 20 marks
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Conducting the experiment and writing report: 5 marks 3. Calculations, results, graph and conclusion: 10 marks 4. Viva voce: 10 marks
Eligibility for SEE: 1. 50% and above (50 marks and above)

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Two questions will be asked and student should execute both. Exam includes quiz and viva voce.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓		✓	✓	✓	
2	✓		✓	✓	✓	
3	✓		✓	✓	✓	
Tick mark (✓) the CO, PO and PSO mapping						

ADAPTIVE SIGNAL PROCESSING

Course Code	**22DCN31**	**Course type**	**IPCC**	**Credits L-T-P**	3 – 0 – 1
Hours/week: L - T- P	3 – 0 – 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To demonstrate the basic concepts and scope of random variables and random processes in adaptive signal processing.
2.	To solve the problems of minimizing mean square error and optimize weights of adaptive Systems such as adaptive linear combiner.
3.	To examine the performance Adaptive systems using the concept of error surface under stationary and non-stationary conditions.
4.	To study and examine the existing adaptive systems and apply the concepts to develop desired adaptive systems for given application.

Required Knowledge of: Signals and Systems, Digital Signal Processing

Unit – I	**Contact Hours: 8**
Introduction to random variables: random processes, characteristics of random variables, mean, variance, standard deviation, moments, moment generating functions, functions of random variables, covariance, correlation coefficient, numericals as applicable.	

Unit – II	**Contact Hours: 8**
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 Wiener Hopf equation- Performance Surface. (Text 1)	

Unit – III	**Contact Hours: 8**
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 – IV	**Contact Hours: 8**
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 – V	Contact Hours: 8
Applications-adaptive modelling: Z-Transform in Adaptive Signal Processing, Multipath communication channel, geophysical exploration, FIR digital filter synthesis. (Text 2) **System identification-adaptive modelling:** Inverse adaptive modelling, equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**2**	Implementation of LMS algorithm, plotting learning curves by increasing iterations and analysing the results.
2	**2**	Design and implementation of Adaptive IIR and FIR digital filter for active noise cancellation and study its performance using simulation and using **DSP KIT.**
3	**1**	Demonstration of System identification and study its performance.
4	**1**	Demonstration of Linear prediction and study its performance.
5	**1**	Demonstration of Inverse Modelling and study its performance.
5	**1**	Design and Implementation of Adaptive notch filtering and study its performance using Matlab Simulation and also implement the same using **DSP KIT.**

Unit No.	Self-Study Topics
1	Characteristic function, Tchebyshev Ineqaulity, Central limit theorem
2	Orthogonality, Automatic Gain Control System
3	Study of Learning Curves of Simple Adaptive Systems
4	Adaptive Recursive and Non-Recursive Filter Structures
5	Adaptive Equalization and Deconvolution.

Books	
	Text Books:
1.	Simon Haykin, Adaptive Filter Theory, Pearson Education, 2003 edition and onwards.
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 Applications - Springer-Verlag.
	E-resourses (NPTEL/SWAYAM.. Any Other)-

	Introduction To Adaptive Signal Processing, By Prof. Mrityunjoy Chakraborty, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc23_ee138/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Use Wiener Hopf Equation to compute the values of optimum weight vectors for any given Adaptive Linear Combiner	Un	2,3	1,2,3
2.	Apply Adaptive Algorithms for the Adaptive Signal Processing to improve the performance of Adaptive Systems.	Ap	2,3	1,2,3
3.	Design and Analyse Basic Adaptive Systems and Adaptive Linear Combiner for a given application.	An	2,3	1,2,3
4.	Test and examine the performance of Existing Adaptive Systems.	Ev	1,2,3	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			LAB (40 marks)		Total
IA test 1	IA test 2	Assignment (OA/Lab Project/ Industry assignment/Course Project)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:
1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:
1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)
1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:
1. 50% and above (30 marks and above) in theory component
2. 50% and above (20 marks and above) in lab component
3. **Lab test is COMPULSORY**

4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥ 40% &, however overall score of CIE+SEE should be ≥ 50%.
3.	Question paper contains three parts **A, B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (planned)				**CO-PSO Mapping (planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1		✓	✓	✓	✓	✓
2		✓	✓	✓	✓	✓
3		✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓
Tick mark the CO, PO and PSO mapping						

SOFTWARE DEFINED NETWORKS

Course Code	**22DCN321**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hrs			**SEE Marks**	100

Course learning objectives	
1.	To Understand the fundamentals of software defined networks and its architecture.
2.	To explore the significance of the data plane and the control plane to develop data exchange network.
3.	To study and analyze the open flow specifications to implement effective SDN Programming.
4.	To design and implement the SDN networks using APIs.

Pre-requisites: Computer Communication Networks, Digital Communication

Unit – I	**Contact Hours: 8**
INTRODUCTION: Understanding the SDN, Understanding the SDN technology, Control Plane, Data Plane, moving information between planes, separation of the control and data planes, Distributed control planes, Load Balancing, Creating the MPLS Overlay, Centralized control planes	

Unit – II	**Contact Hours: 8**
WORKING OF SDN: Evaluation of Switches and Control planes, SDN Implications, Data centre Needs, Forerunner of SDN, Software Defines Networks is Born, Sustain SDN interoperability, Open-source contribution, Fundamental Characteristics of SDN, SDN Operations, SDN Devices, SDN Controllers, SDN Applications, Alternate SDN methods	

Unit – III	**Contact Hours: 8**
THE OPEN FLOW SPECIFICATIONS: Open Flow Overview, Open Flow Basics, How OpenFlow Works, Open Flow 1.1, Open Flow 1.2, Open Flow 1.5 additions, Open Flow limitations. Application Scenarios of OpenFlow. Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE.	

Unit – IV	**Contact Hours: 8**
SDN via APIS, SDN via Hypervisor-Based Overlays, SDN via Opening up the device, Network function virtualization, Alternative Overlap and Ranking, Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Illustration of Inband Network Telemetry (INT), SDN enabled broadband access.	

Unit – V	Contact Hours: 8
Data centers definition, Data centers demand, tunnelling technologies for Data centers Path technologies in data centers, Ethernet fabrics in Data centers, SDN use case in Data centers. Juniper SDN Framework – IETF, SDN Framework, Future of SDN. Secure Enterprise SDN (SES) solution: User onboard system and end point security check module.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Software Defined Networking by Thomas D Nadeau and Ken Gray.
2.	Software Define Networks, A Comprehensive Approach, Paul Goransson, Chuck Black. MK Publications.
3.	Paul Goransson and Chuck Black, ―Software Defined Networks: A Comprehensive Approach, First Edition, Morgan Kaufmann, 2014.
	Reference Books:
1.	Software Defined Networking for Dummies brought you by cisco, Brian Underdahl and Gary Kinghorn
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Software Defined networking by Prof. Sandeep Chakraborty, IIT Kharagpur. https://www.youtube.com/watch?v=CaukSKg_sI0
2.	Introduction to Computer Networks and Internet protocols by Prof. Bhushan Trivedi. https://onlinecourses.swayam2.ac.in/cec21_cs19/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Illustrate the basics of Software Defined Networks Operations and Data flow.	Un	3	1
2.	Classify different Software Defined Network Operations in real world problem	Ap	3	1,2
3.	Contrast different Software Defined Network Operations and	An	2,3	1,2

	Analyse alternative implementations of Software Defined Networks			

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B& C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (planned)				**CO-PSO Mapping (planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO 1**	**PSO 2**	**PSO 3**
1			✓	✓	✓	
2			✓	✓	✓	
3		✓	✓	✓	✓	
Tick mark the CO, PO and PSO mapping						

RF AND MICROWAVE CIRCUIT DESIGN

Course Code	**22DCN322**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To study the theoretical foundations, concepts and properties of RF microwave circuits/components.
2.	To determine various parameters for evaluating the performance for RF/microwave circuits/components.
3.	To learn the development of RF/microwave circuits/component front-end functional blocks.

Pre-requisites: Engineering Mathematics; Electromagnetic Theory and Antenna Engineering; Microwave and Radar Engineering

Unit – I	**Contact Hours: 8**
Wave Propagation in Networks: Introduction, Reasons for using RF/Microwaves, Applications, RF waves, RF and Microwave circuit design, Introduction to components basics, Analysis of simple circuit phasor domain, RF impedance matching, Properties of waves, transmission media, Micro strip lines, High frequency parameters, Formulation of S-parameters, Properties, transmission matrix, Generalized S-parameters.	

Unit – II	**Contact Hours: 8**
Overview of RF Filter Design: - Basic Resonator and filter configurations: filter types and parameters, LP, HP, BP, BS filters and insertion loss; Special Filter Realizations: Butterworth, Chebyshev, denormalization of standard LP design; Filter implementations: Unit elements, Kuroda's Identities, Microstrip filter design examples; Coupled Filters: odd and even modes of excitation, BPF section, cascading BPF elements, design example;	

Unit – III	**Contact Hours: 8**
Matching and Biasing Networks: - Impedance matching using discrete components: 2 component matching networks, forbidden regions, freq. response, Q-factor, T, Pi matching networks; microstrip line matching networks: from discrete to microstrip lines, single and double stub matching networks; amplifier classes of operation and biasing networks: operation classes, efficiency, BJT FET biasing matching networks	

Unit – IV	Contact Hours: 8
RF Transistor Amplifier Design: - characteristics of amplifiers; amplifier power relations: RF source power gain and power relations; stability considerations: stability circles, unconditional stability, and stabilization measures; constant gain: unilateral design, Figure of Merit, bilateral design, operating and available power gains; noise figure circles; constant VSWR circles; broadband, high power multistage amplifiers	

Unit – V	Contact Hours: 8
Oscillators and Mixers: - Basic oscillators model: negative resistance, FB oscillator, design steps; high frequency oscillators configurations: fixed frequency, dielectric resonator, YIG tuned, VCO, Gunn element; basic characteristics of mixers: basic concepts, frequency domain considerations, single ended mixer design, single and double balanced mixer;	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education edition, 2004.
2.	Reinhold Ludwig, and Pavel Bretchko, "RF circuit design theory and applications", Pearson Education edition, 2004
	Reference Books:
1.	D. Pozar, Microwave Engineering, J. Wiley and Sons, 3rd Edition, 2004
2.	K. Chang, I. Bahl, and V. Nair, RF and Microwave Circuit and Component Design for Wireless Systems, J. Wiley & Sons, 2002
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	RF and Microwave Networks, by Prof. Bratin Ghosh, IIT Kharagpur: https://nptel.ac.in/courses/108105189
2.	Design Principles of RF and Microwave Filters and Amplifiers, by Prof. Amitabha Bhattacharya, IIT Kharagpur https://nptel.ac.in/courses/117105138

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Illustrate the requirement of RF circuit for various applications.	Un	3	1,2
2.	Discover the requirements of various components for the specified design criteria.	An	3	1,2
3.	Estimate and design circuits for the specified RF applications.	Ev	1, 3	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A, B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓	✓	✓	
2			✓	✓	✓	
3	✓		✓	✓	✓	

SOFTWARE DEFINED RADIO

Course Code	**22DCN323**	**Course type**	**Integrated Project based PEC**	**Credits L-T-P**	2 – 0 – 1
Hours/week: L - T- P	2 – 0 – 2			**Total credits**	3
Total Contact Hours	L = 20 Hrs, T = 0 Hrs, P = 20 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	3			**SEE Marks**	100

Course learning objectives	
1.	To understand the digital transmission fundamentals, optimal detection and receiver realizations.
2.	To explore basics of SDR implementations of transmitter and receiver.
3.	To design transmitter and receiver from the waveform synthesis perspective.
4.	To design efficient SDR based implementation of multicarrier communication systems for various RF applications.

Pre-requisites: Analog and Digital Communication, Basic and Advanced Digital Signal Processing

Unit – I	**Contact Hours: 4**

Digital Transmission Fundamentals:
Digital Transmission: Source encoding, channel encoding
Digital Modulation: Power efficiency, pulse amplitude modulation, quadrature amplitude modulation, phase shift keying, power efficiency summary
Probability of Bit Error: Error bounding, signal space concept, Gram-Schmidt orthogonalization,
Optimal Detection: Signal vector framework, decision rules, maximum likelihood detection in an AWGN channel
Basic Receiver Realizations: Matched filter realization, correlator realization

Unit – II	**Contact Hours: 4**

Basic SDR Implementation of a Transmitter and a Receiver:
Software Implementation: Repetition coding, interleaving, BER calculator, receiver implementation over an ideal channel
USRP Hardware Implementation: Frequency offset compensation, finding wireless signals: observing IEEE 802.11 WiFi networks, USRP in-phase/quadrature representation

Unit – III	**Contact Hours: 4**

Receiver Structure and Waveform Synthesis of a Transmitter and a Receiver:
Software Implementation: Observation vector construction, maximum-likelihood decoder implementation, correlator realization of a receiver in Simulink.
USRP Hardware Implementation: Differential binary phase-shift keying, differential quadrature phase-shift keying, accelerate the Simulink model that uses USRP blocks.

Unit – IV	**Contact Hours: 4**

Multicarrier Modulation and Duplex Communications:
Theoretical Preparation: Single carrier transmission, multicarrier transmission, dispersive channel environment, OFDM with cyclic prefix, frequency domain equalization, bit and power allocation.
Software Implementation: MATLAB design of multicarrier transmission, Simulink design of OFDM
USRP Hardware Implementation: Eye diagram, matched filter observation

Unit – V	Contact Hours: 4
Spectrum Sensing Techniques **Theoretical Preparation:** Power spectral density, practical issues of collecting spectral data, hypothesis testing, spectral detectors and classifiers, **Software Implementation:** constructing energy detector, observing cyclostationary detector USRP Hardware Experimentation	

List of Experiments

Unit No.	No. of Experiments	Title of the Experiment
1	2	SDR implementation of AM and FM transmitter and receiver.
2	3	SDR implementation of: (i) ASK (ii) FSK (iii) PSK
3	2	SDR implementation of: (i) QPSK (ii) QAM
4	1	SDR implementation of OFDM.
5	1	Configuring SDR as RF spectrum analyzer.

Unit No.	List of Open-Ended Projects
3	Frame Synchronization, Barker Code, Simulink Models.
4	Duplex Communication, Half-Duplex, Time-Division Duplexing
5	Carrier Sense Multiple Access, Collision Avoidance (CSMA/CA)

Books	
	Text Books:
1.	Di Pu, Alexander M. Wyglinski, “Digital Communication Systems Engineering with Software-Defined Radio”, 2013, ISBN-13: 978-1-60807-525-6.
2.	Travis F. Collins, Robin Getz, Di Pu, Alexander M. Wyglinski, “Software-Defined Radio for Engineers”, 2018, ISBN-13: 978-1-63081-457-1.
	Reference Books:
1.	Waqar Hussain et.al., “Computing Platforms for Software-Defined Radio”, Springer, 2017.
2.	Robert W. Stewart, “Software Defined Radio Using MATLAB & Simulink and the RTL-SDR”, Strathclyde Academic Media, 2015.
3.	Eugene Grayver, “Implementing Software Defined Radio”, Springer, 2012.
4.	Vito Giannini, Jan Craninckx and Andrea Baschirotto, “Baseband Analog Circuits for Software Defined Radio (Analog Circuits and Signal Processing)”, Springer, 2008.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Basics of software defined Radios, by Prof. Meenakshi Rawat, IIT Roorkee https://onlinecourses.nptel.ac.in/noc22_ee78/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests- Theory & Lab based
2.	PPT and Videos	2.	Project phase 1 & 2
3.	Practice session/Demonstrations in Labs	3.	SEE- Project evaluation
		4.	SEE- Solving an Open-ended problem

Course Outcome (COs) **Learning Levels:** **Re - Remember, Un - Understand, Ap - Apply, An - Analysis, Ev - Evaluate, Cr - Create**				
At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand and apply the fundamental concepts of software defined radios to configure the SDR hardware as transmitters and receivers.	Ap	3	1
2.	Analyze the performance of SDR implementation of transmitter and receiver under the effects of channel.	An	1,3	1,2
3.	Design and evaluate the performance of SDR implementation of RF communication systems.	Ev	1,2,3	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (40 marks)		**PROJECT (60 marks)**			Total
IA test (Theory)	IA test (Lab)	Project Phase 1	Project Phase 2	Project report	
25 marks	15 marks	25 marks	25 marks	10 marks	100 marks
Theory IA test should be of one-hour duration. Lab IA test should be of two/three-hour duration. Project batch will ideally consist of 2 students (maximum of 3). Project Phase 1 presentation will be conducted after 6 weeks and Project Phase 2 presentation will be conducted after 13 weeks from the start of the semester. Submitting Project report is compulsory.					
Eligibility for SEE: 1. 50% and above (20 marks and above) in theory component 2. 50% and above (30 marks and above) in project component 3. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Semester End Examination (SEE):

1.	It will be conducted for 100 marks having 3 hours duration.		
2.	**Lab Open ended program/problem/experiment** Write-up & execution (1 open ended expt)- (20 marks write-up + 20 marks algorithm/flowchart + 10 marks execution)	50 marks	100 marks
	Project evaluation a. Initial write up stating the objectives, methodology and the outcome b. Hardware project: Exhibiting and demonstration of working of project. Software project: Demonstration of the programming capabilities by writing flowchart, algorithm and codes related to a section of the project. c. Viva-voce	10 marks 30 marks 10 marks	
3.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.		
4.	SEE will be conducted in project batches by **Internal & External examiners** together.		

CO-PO Mapping (planned)				CO-PSO Mapping (planned)		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓	✓		
2	✓		✓	✓	✓	
3	✓	✓	✓	✓	✓	✓
Tick mark the CO, PO and PSO mapping						

ERROR CONTROL CODING

Course Code	**22DCN324**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the concepts of modern algebra that are necessary to understand the Error Control Coding.
2.	To design Linear Block codes and important classes of linear codes in communication.
3.	To design the error detection and correction system using BCH codes for error detection and implement hardware and software for BCH decoders.
4.	To understand the importance of majority-logic decodable codes and develop basic state diagram to study convolutional code structure and distance properties along with Viterbi decoding algorithm.

Pre-requisites: 1. Principles of Communication Systems 2. Digital Communication

Unit – I	**Contact Hours: 8**
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	

Unit – II	**Contact Hours: 8**
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, Hamming codes	

Unit – III	**Contact Hours: 8**
Important Linear block 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 – IV	**Contact Hours: 8**
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 – V	Contact Hours: 8
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, Viterbi decoding algorithm for decoding Introduction to low density parity check (LDPC) codes.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	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.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
		4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the fundamentals required to learn and apply error control coding techniques for reliable communication of information.	Un	3	1
2.	Apply the concept of modern linear algebra for the design of channel encoder and decoder to control channel errors using error control coding techniques.	Ap	2,3	1
3.	Develop and analyze the encoding and decoding procedures of	An	2,3	1

	different error control codes.			

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 50 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓	✓		
2		✓	✓	✓		
3		✓	✓	✓		
Tick mark the CO, PO and PSO mapping						

REAL TIME SYSTEMS

Course Code	**22DCN331**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To study the basic of tasks and scheduling.
2.	To understand programming languages and databases
3.	To analyze real time communication
4.	To analyze evaluation techniques and reliability models for Hardware Redundancy
5.	To understand clock synchronization

Pre-requisites: Operating Systems

Unit – I	**Contact Hours: 8**
Introduction to task scheduling: Issues in real time computing, structure of a real time system, Hard vs Soft RT tasks, task classes, performance measures for real time systems, task assignment and scheduling – classical uniprocessor scheduling algorithms, RM algorithm with different cases-priority ceiling-precedence constraints- using of primary and alternative tasks Case study: RTOS used in industries (Comparative analysis)	

Unit – II	**Contact Hours: 8**
Uni and multi-processor scheduling: Uniprocessor scheduling of IRIS tasks, task assignment, utilization balancing – Next fit- bin packing, myopic off-line, focused addressing and bidding, Buddy strategy- fault tolerant Scheduling, aperiodic scheduling - spring algorithm, horn algorithm, Bratley, sporadic scheduling	

Unit – III	**Contact Hours: 8**
Real time communication: Introduction – VTCSMA, PB CSMA – deterministic collision resolution protocol, DCR for multi packet messages, dynamic planning based, communication with periodic and aperiodic messages.	

Unit – IV	**Contact Hours: 8**
Real time databases: Basic definition, real time vs general purpose databases, main memory databases, transaction priorities, transaction aborts, concurrency control issues, disk scheduling algorithms, two-phase approach to improve predictability, maintaining serialization consistency, databases for hard real time system.	

Unit – V	Contact Hours: 8
Real-time modeling and case studies: Petrinets and applications in real-time modeling, air traffic controller system, Distributed air defense system.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	C.M. Krishna, Kang G. Shin, "Real Time Systems", Tata McGraw - Hil, 2010.
2.	Giorgio C. Buttazzo , "Hard real-time computing systems: predictable scheduling algorithms and applications" , Springer, 2008.
3.	C. Siva Ram Murthy, G. Manimaran, "Resource management in real-time systems and networks", PHI, 2009.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Real Time Systems, by Prof. Rajib Mall, IIT Kharagpur, https://nptel.ac.in/courses/106105036

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar/Project
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Classify different scheduling policies in RTS and interpret application of real time concepts to databases	Ap	3	2
2.	Examine the working of real time system	An	3	2
3.	Perceive RTS modeling and provide solutions to real time applications	Ev	2,3	2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A, B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓		✓	
2			✓		✓	
3		✓	✓		✓	✓
Tick mark the CO, PO and PSO mapping						

MEMS AND SENSORS

Course Code	**22DCN332**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0– 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40Hrs; T = 0Hrs; P = 0Hrs Total = 40Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To understand the fabrication and machining techniques of MEMS devices.
2.	To familiarize with the concepts of MEMS switches, relays.
3.	To study the RF-MEMS applications.
4.	To analyze the specifications and types of sensors for different applications

Pre-requisites: Electric and electronic circuits, physics basics

Unit – I	**Contact Hours: 8**
MEMS: Introduction, MEMS, micro fabrications for MEMS, electromechanical transducers piezoelectric transducers, electrostrictive transducers, electrostatic actuators, electro thermal actuators, microsensing for MEMS, materials for MEMS, metal and metal alloys for MEMS, polymers for MEMS.	

Unit – II	**Contact Hours: 8**
MEMS SWITCHES AND MICRO RELAYS: Introduction, switch parameters, basics of switching, actuation mechanisms for MEMS devices, MEMS switch design, modeling and evaluation, RF design, MEMS switch design considerations.	

Unit – III	**Contact Hours: 8**
RF-MEMS APPLICATIONS: Introduction, brief History of MEMS and RF-MEMS from the perspective of Technology, RF-MEMS lumped components, variable capacitors, inductors, Ohmic and capacitive switches, MEMS complex networks, reconfigurable impedance-matching networks, reconfigurable RF power attenuators.	

Unit – IV	**Contact Hours: 8**
PRESSURE SENSORS: Pressure sensor specifications, dynamic pressure sensing, pressure sensor types, traditional pressure sensors, manometer, aneroid barometers, bourdon tube, vacuum sensors, diaphragm-based pressure sensors. **Case study: applications using pressure sensor.**	

Unit –V	Contact Hours: 8
INERTIAL SENSORS: Introduction, micromachined accelerometer, principle of operation, research prototype of micromachined accelerometers, commercial micromachined accelerometer, micromachined Gyroscopes, principle of operation, commercial micromachined Gyroscopes.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	Vijay K. Varadan K.J. Vinoy K.A. Jose "RF MEMS and Their Applications", John Wiley & Sons Ltd, 2003
2.	Jacopo Iannacci "Practical Guide to RF-MEMS", June 2012.
3.	Stephen Beeby, Graham Ensell, Michael Kraft,Neil White, "MEMS Mechanical Sensors",
	Reference Books:
1.	Héctor J. De Los Santos "RF MEMS Circuit Design for Wireless Communications", 2002

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Illustrate the MEMS technology, materials, fabrication and devices.	Un	3	1
2.	Examine the MEMS and sensors for different applications.	Ap	2, 3	1
3.	Characterize different MEMS devices, sensors principles and operations to find the advancements.	An	2, 3	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment
Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B& C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping(Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓	✓		
2		✓	✓	✓		
3		✓	✓	✓		
Tick mark the CO, PO and PSO mapping						

MODELING SIMULATION AND ANALYSIS OF PHYSICAL SYSTEMS

Course Code	22DCN333	Course type	OEC	Credits L-T-P	3 – 0 – 0
Hours/week: L – T – P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 30 Hrs.; T = 0 Hrs.; P = 10 Hrs. Total = 40 Hrs.			CIE Marks	100
Flipped Classes content	5 Hours			SEE Marks	100

Course Learning Objectives	
1.	To illustrate the fundamental concepts related to mathematical modeling of physical systems.
2.	To comprehend the concepts related of lumped parameter-based modeling of system elements.
3.	To explore the scopes of Canonical form-based system modeling for lower order electrical, mechanical, hydraulic, and thermal systems.
4.	To analyse the responses of the modeled systems in time domain and in frequency domain with static and fluctuating input conditions.
5.	To evaluate the effects of feedback on industrial processes.
6.	To design composite controllers for controlling of dynamic real time processes.

Pre-requisites: Engineering mathematics, solution of differential equation, linear algebra

Unit – I	Contact Hours: 8
Fundamental Concepts related to Modeling of Physical Systems: Necessity of system modeling, basic principles behind mathematical modeling of systems, 'Wisdom Hierarchy' of system model in this age of data, many to one and one to many approaches of system modeling, basic block representation of systems in real world and in mathematical world, abstraction concept and related examples in system modeling, approximation, validation and error analysis in system model, system model from given data	

Unit – II	Contact Hours: 8
Lumped Parameter Model of Physical Systems: Linearity and superposition, balance and conservation laws of the system, boundary approach of system model, modeling of automobile suspension system with spring, mass, and damper, modeling of optoelectronic instrumentation system, modeling of electrical systems, determination of model equation for outlet of a hydraulic storage tank, finding the governing equations of thermal systems with node rule and loop rule **Simulation & Analysis –** MATLAB based modeling and system response analysis for automobile, thermal and electrical systems, concept of hardware in the loop (HIL) for testing of automobile & ADAS.	

Unit – III	Contact Hours: 8
Canonical form Modeling of Physical Systems and System Response Analysis in Time Domain: Electrical and mechanical system modeling in Canonical form by using system boundary approach and free body diagram approach, modeling of liquid storage tank with laminar flow through outlet pipe, basics of Canonical form of lower order systems and related system responses, application of superposition principle for solving water back flow problem of washing machine through drainage pipe, modeling of spring-mass and pendulum systems subjected to gravitational force, higher order	

physical system transient response analysis under dynamic conditions

Simulation & Analysis – MATLAB based analysis of pendulum movement, response of LC tank circuit.

Unit – IV	**Contact Hours: 8**

Responses Analysis in Frequency Domain for Modeled Physical Systems: Mathematical model of liquid storage system insensitive to rapid input fluctuation, frequency response analysis of voltage bias network and determination of its passband for variable capacitance, response analysis of mechanical systems under various dynamic conditions, mathematical model for resonance in electrical and mechanical systems, dynamic vibration absorber, frequency response analysis of continuous stirred tank reactor with transportation delay, steady state displacement analysis of mechanical systems, concept of mechanical impedance, empirical analysis of system frequency response for mass coupled with moving base, stability free response & phase plane trajectory of spring mass oscillator using state space modeling

Simulation & Analysis – MATLAB based (Bode plot) analysis for determination of liquid outflow from storage tank with rapid input fluctuations, band pass system responses with different operational speeds, concepts of gain margin, phase margin, and system stability in frequency domain.

Unit – V	**Contact Hours: 8**

Industrial Process Control and Composite Controllers: Basics of industrial process control and process control parameters, single-loop and multiloop systems and their control, dynamics of a thermal processing system for semiconductor chip design, plant dynamics of a satellite orientation system in the vacuum, effects of feedback on overall gain, parametric sensitivity, external noise and system stability, frequency domain system stability analysis using gain and phase margin concept for 2^{nd} and 3^{rd} order feedforward transfer function and for 1^{st} order feedforward transfer function with delay, tuning of composite controllers and its uses in industrial process control

Simulation & Analysis – MATLAB based design and response analysis of composite PID controllers, tuning of PID controller as per speed of the process, software in the loop (SIL) concept.

Books	
	Text Books:
1.	Philip D Cha, James J Rosenberg and Clive L Dym, "Fundamentals of Modeling and Analyzing Engineering Systems", Cambridge University, 2000.
2.	Amalendu Mukherjee, Ranjit Karmakar, "Modeling and Simulation of engineering Systems through Bondgraphs", Narosa, 2000.
3.	Curtis D. Johnson, "Process Control Instrumentation Technology", Pearson New International Edition, 8^{th} Edition, 2014, ISBN 10: 1-292-02601-4.
	Reference Books:
1.	Close Frederick, "Modeling and Analysis of Dynamic Systems", Wiley.
2.	Woods, Robert L., and Lawrence Kent L, "Modeling and Simulation of Dynamic Systems", Prentice Hall, 1997.

Course Delivery Methods		**Assessment Methods**	
1.	Chalk and Talk	1.	IA Tests
2.	PPT and Self-Created Videos Sessions	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online Video Based Explanations	4.	Course Seminar and Report (Group Activity)

5.	Google Classroom Based Submissions	5.	Semester End Examination

Course Outcome (COs) - At the end of the course, the student will be able to				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	demonstrate the basic concepts learnt about system modeling and compare the mathematical models of various physical systems.	Un	1	1
2.	develop the system models for 1st order and 2nd order physical systems by using lumped parameter and Canonical form based modeling techniques.	Ap	1, 3	1, 2, 3
3.	examine the responses of modeled physical systems in time domain and in frequency domain and inspect their special features.	An	1, 2, 3	1, 3
4.	estimate the system stability and parametric sensitivity with feedback and composite controllers.	Ev	1, 2, 3	1, 2, 3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment - Minimum score to be eligible for SEE: 50 OUT OF 100					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A, B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1	✓			✓		
2	✓		✓	✓	✓	✓
3	✓	✓	✓	✓		✓
4	✓	✓	✓	✓	✓	✓

INTERNET OF THINGS AND INDUSTRIAL APPLICATIONS

Course Code	22DCN334	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 – 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	5 Hours			**SEE Marks**	100

Course learning objectives	
1.	To learn the concept of Internet of Things (IoT) and identify its significance, and describe its various components and applications.
2.	To learn smart and connected business perspective called as Industry IOT.
3.	To Identify the emerging issues in Industries and to develop the smart factory concept in Industries using IOT model.
4.	To explore the unique security challenges posed by IIoT systems.
5.	To Identify and describe key application domains of Industrial IoT (IIoT) in industries such as healthcare, power plants, inventory management, quality control, plant safety, and security.

Pre-requisites: Basic understanding of electronics and programming (C/C++ or Python). Basics of Electronics & Electrical Devices

Unit – I Fundamentals of IoT	**Contact Hours: 8**
Introduction to IOT, Evolution of Internet of Things, Physical Design and Logical Design of IOT, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects, IOT levels and Deployment Templates. **Hands on Session**: Building a simple IoT sensor node.	

Unit – II	**Contact Hours: 8**
Industrial IoT: IIoT-Business Models, IIoT Reference Architecture, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Globalization and Emerging Issues Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems. **Hands on Session**: Creating a temperature and humidity monitoring system.	

Unit-III	**Contact Hours: 8**
Industrial IoT Security Cloud Computing, Fog Computing in IIoT, Cybersecurity Basics: Confidentiality, Integrity, Availability (CIA), Security Goals in IIoT, and The CIA Triad in IIoT: Challenges and Implications,	

Industry-specific IIoT Security Standards and Regulations. Security Issues in IIOT: Device Vulnerabilities, Unauthorized Access, Data Privacy and Confidentiality, Lack of Security Updates, Supply Chain Risks, Lack of Security Awareness **Hands On Session**: Configuring IIoT Security Measures

Unit – IV	**Contact Hours: 8**
Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry, Healthcare, Power Plants, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Inventory Management & Quality Control. **Hands On Session**: Design any one Industrial application prototype using IoT models.	

Unit – V	**Contact Hours: 8**
IoT Advanced Projects and case studies: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries. Real case studies: Case study-I: Milk Processing and Packaging Industries, Case study - II : Virtual Reality Lab, Case study - III : Steel Technology Lab, Case study - IV: Manufacturing Industries. **Hands on Session**: Developing a complete IoT project with advanced features.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions		**1**	**1**	**1**	**2**

Books	
	Text Books:
1.	"Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress).
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things A hands on approach", Universities Press, 2015 ISBN: 978-81-7371-954-7.
3.	"IoT for Beginners: An Easy DIY Guide to Designing Your First Internet of Things Project" by Jonathan Cox and Timothy Short
4.	
	Reference Books:
1.	"Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer).
2.	Research papers
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL course:** **Introduction to Industry 4.0 and Industrial Internet of Things** https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Demonstrate a strong understanding of the fundamental concepts of the Internet of Things (IoT), including its significance, components, and applications.	Un	3	1
2.	Identify the emerging issues in Industries and to develop the Industry application prototype model using IOT model.	Ap	3	2,3
3.	Identifying and Investigating Emerging Security Challenges in IIoT.	Ap	3	2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs or Course Project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment

Minimum score to be eligible for SEE: 50 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 40%, however overall score of CIE + SEE should be $\geq$ 50%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)				**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
1			✓			
2			✓			
3			✓			
Tick mark the CO, PO and PSO mapping						