M.E. Degree

in

COMMUNICATION SYSTEMS

CURRICULUM & SYLLABUS (CBCS)

(For students admitted from the Academic Year 2022-2023)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629003

AUTONOMOUS COLLEGE AFFILIATED TO ANNA UNIVERSITY

ACADEMIC REGULATIONS 2022

M.E. COMMUNICATION SYSTEMS CURRICULUM

CHOICE BASED CREDIT SYSTEM

Inconsonance to the vision of our College,

An engineering graduate we form would be a person with optimal human development, i.e. physical, mental, emotional, social and spiritual spheres of personality.

He/she would be also a person mature in relationships, especially knowing how to treat everyone with respect, including persons of complementary gender with equality and gender sensitivity guided by clear and pro-social values.

He would be patriotic and would hold the Indian Constitution and all the precepts it outlays close to his heart and would have a secular spirit committed to safeguard and cherish the multi-cultural, multi- religious and multi-linguistic ethos of Indian Society.

Academically, he/she would be a graduate with a strong engineering foundation with proficient technical knowledge and skills. He would have enough exposure and experience into the ethos of relevant industry and be industry ready to construct a successful career for himself and for the benefit of the society.

He would have been well trained in research methodology and would have established himself as a researcher having taken up many research projects, with sound ethical standards and social relevance. He would be a person with a passion for technical innovations committed to lifelong learning and research.

He would be well prepared and confident to develop ingenuous solutions to the problems people face as an individual and as a team and work for the emancipation of our society with leadership and courage.

ME (Communication Systems) is a PG course in Electronics and Communication Engineering that is made to acquire in-depth knowledge of Digital Communication, RF & Microwave, Signal Processing and Networking, including wider and global perspective. The course is for 2 years which is then divided into 4 semesters.

This course offers a comprehensive, in-depth study of the working of Communication systems made up of devices that employ one of the two communication methods(wired or wireless), different types of equipment such as portable radios, mobile radios, base/fixed station radios, and repeaters, and/or various enhancements to meet the user's needs.

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I	Apply technical knowledge and skills to have successful career in industry, government and academia as communication engineers.
II	Pursue multidisciplinary scientific research in communication and related areas for the benefits of society.
III	Make use of various state-of art systems and cutting edge technologies to solve various complex engineering problems.
IV	Inculcate leadership skills, team work, effective communication and lifelong learning to the success of their organization and nation.
V	Practice ethics and exhibit commitment in profession to empower / enable rural communication infrastructure.

II. PROGRAMME OUTCOMES (POs)

PO	Programme Outcomes
1	Independently carry out research/investigation and development work to solve practical problems.
2	Write and present substantial technical report/document.
3	Demonstrate a degree of mastery over the techniques in the area of communication systems.
4	Analyze and design the subsystems in RF, signal processing, modern communication systems and networks.
5	Solve problems in communication system design using advanced hardware and software tools.
6	Measure electromagnetic interference and mitigate its effects.

PEO's – PO's MAPPING

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	1	**2**	**3**	**4**	**5**	**6**
I	2	1	2	3	3	2
II	3	1	2	3	3	2
III	3	1	3	3	3	2
IV	2	1	2	-	-	-
V	1	1	2	-	-	2

PROGRAMME ARTICULATION MATRIX

Year	Semester	Course Name	PO					
			1	2	3	4	5	6
I	I	Applied Mathematics for Communication Engineers	-	-	2	1.6	2	-
		Modern Digital Communication Systems	2	1.8	2	1.8	-	-
		Statistical Signal Processing	1.6	1.4	1.2	1.6	1.6	-
		Digital Communication Systems Laboratory	2	-	2	2	2	-
I	II	Advanced Wireless Communication	2	2	1	2	1	1
		Microwave Circuits	1	1	2	1	1	1
		Radiating Systems	2	-	2	2	2	2
		Machine Learning	2	1.8	1.8	1.8	1.6	1.8
		Wireless Communication Laboratory	1.5	2	1	-	-	-

M.E. COMMUNICATION SYSTEMS CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1	MA22104	Applied Mathematics for Communication Engineers	FC	3	1	0	4	4
2	CU22102	Modern Digital Communication Systems	PCC	3	0	0	3	3
3		Professional Elective I	PEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
4	CU22101	Statistical Signal Processing	PCC	3	0	2	5	4
PRACTICAL COURSES								
5	CU22103	Digital Communication Systems Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
6	CU22104	Technical Seminar	EEC	0	0	2	2	1
7	RM22101	Research Methodology	RMC	2	0	0	2	2
MANDATORY COURSES								

8		Audit Course I	AC	2	0	0	2	0
TOTAL				**16**	**1**	**8**	**25**	**19**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1	CU22204	Advanced Wireless Communication	PCC	3	0	0	3	3
2		Professional Elective II	PEC	3	0	0	3	3
3		Professional Elective III	PEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
4	CU22201	Microwave Circuits	PCC	3	0	2	5	4
5	CU22202	Radiating Systems	PCC	3	0	2	5	4
6	CU22203	Machine Learning	PCC	3	0	2	5	4
PRACTICAL COURSES								
7	CU22205	Wireless Communication Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
8	RM22201	Research Tool Laboratory	RMC	0	0	4	4	2
MANDATORY COURSES								
9		Audit Course II	AC	2	0	0	2	0
TOTAL				**20**	**0**	**14**	**34**	**25**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1		Professional Elective V	PEC	3	0	0	3	3
2		Open Elective	OEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
3		Professional Elective IV	PEC	3	0	2	5	4
EMPLOYABILITY ENHANCEMENT COURSES								
4	CU22301	Inplant / Industrial / Practical Training (4 weeks during	EEC	0	0	4	4	2

		summer vacation)						
5	CU22302	Project Work I	EEC	0	0	6	6	3
TOTAL				**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
EMPLOYABILITY ENHANCEMENT COURSES								
1	CU22401	Project Work II	EEC	0	0	24	24	12
TOTAL				**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 71

PROFESSIONAL ELECTIVES

SEMESTER I, PROFESSIONAL ELECTIVE – I

S. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AE22111	Applications Specific Integrated Circuits	PEC	3	0	0	3	3
2.	AE22112	Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3
3.	CU22111	Advanced Satellite Communication and Navigation Systems	PEC	3	0	0	3	3
4.	CU22112	High Speed Switching and Networking	PEC	3	0	0	3	3
5.	AE22115	Soft Computing and Optimization Techniques	PEC	3	0	0	3	3

SEMESTER II, PROFESSIONAL ELECTIVE – II

Sl. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU22211	Multimedia Compression Techniques	PEC	3	0	0	3	3
2.	CU22212	Cognitive Radio Networks	PEC	3	0	0	3	3
3.	CU22213	Speech Processing	PEC	3	0	0	3	3
4.	CU22214	Analog and Mixed Signal VLSI Design	PEC	3	0	0	3	3
5.	CU22215	Wavelets and Subband Coding	PEC	3	0	0	3	3

SEMESTER II, PROFESSIONAL ELECTIVE – III

Sl. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU22221	Ultra Wide Band Communications	PEC	3	0	0	3	3
2.	CU22222	VLSI for Wireless Communication	PEC	3	0	0	3	3
3.	CU22223	MEMS and NEMS	PEC	3	0	0	3	3
4.	CU22224	Advanced Antenna Design	PEC	3	0	0	3	3
5.	CU22225	mmWave Communication	PEC	3	0	0	3	3

SEMESTER III, PROFESSIONAL ELECTIVE – IV

Sl. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU22311	Image Processing and Video Analytics	PEC	3	0	2	5	4
2.	CU22312	Radar Signal Processing	PEC	3	0	2	5	4
3.	CU22313	Telecommunication System Modeling and Simulation	PEC	3	0	2	5	4
4.	CU22314	Signal Detection and Estimation	PEC	3	0	2	5	4
5.	CU22315	Real Time Embedded Systems	PEC	3	0	2	5	4

SEMESTER III, PROFESSIONAL ELECTIVE – V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CU22321	Software Defined Radios	PEC	3	0	0	3	3
2.	CU22322	RF System Design	PEC	3	0	0	3	3
3.	CU22323	Advanced Wireless Networks	PEC	3	0	0	3	3
4.	CU22324	Optical Communication and Networking	PEC	3	0	0	3	3
5.	AE22322	Digital High Speed Design	PEC	3	0	0	3	3

AUDIT COURSES (AC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AC22101	English for Research Paper Writing	2	0	0	0
2.	AC22102	Constitution of India	2	0	0	0
3.	AC22201	Disaster Management	2	0	0	0
4.	AC22202	நற்றமிழ் இலக்கியம	2	0	0	0

SUMMARY

M.E. Communication Systems						
S.No	Subject Area	Credits per Semester				Total Credits
		I	II	III	IV	
1	FC	4	-	-	-	4
2	PCC	9	17	-	-	26
3	PEC	3	6	7	-	16
4	OEC	-	-	3	-	3
5	EEC	1	2	5	12	20
6	RMC	2	-	-	-	2
7	Non-Credit AC	0	0	-	-	0
Total		**19**	**25**	**15**	**12**	**71**

SEMESTER I

MA22104	APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- Grasp the basic concepts of probability, random variables, correlation and regression
- Characterize the phenomena which evolve with respect to time in a probabilistic manner
- Encourage students to develop a working knowledge of the central ideas of linear algebra
- Acquire skills in analyzing queueing models
- To acquaint the student with Fourier transform techniques used in wide variety of situations

UNIT I	LINEAR ALGEBRA	12

Norms – Inner products – Gram-Schmidth orthogonolization process - QR factorization – Cholesky decomposition - Generalized eigen vectors – Singular value decomposition and applications-Pseudo inverse – Least square approximations.

UNIT II	PROBABILITY AND RANDOM VARIABLES	12

Probability Concepts – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability functions – Two-dimensional random variables – Joint distributions – Marginal and conditional distributions – Correlation – Linear Regression.

UNIT III	RANDOM PROCESSES	12

Classification – Stationary random process - Strict sense stationary process – Wide sense stationary process – Markov process – Markov chain – Poisson process - Discrete parameter Markov chain - Chapman Kolmogorov equations (Statement only) - Limiting distributions – Auto correlation – Cross correlation.

UNIT IV	QUEUEING THEORY	12

Elements of a queueing system – Kendall's notation - Markovian queues – Single channel ueueing model - multi channel queueing model – Little's formula – Steady state analysis – Self-service queue.

UNIT V	FOURIER TRANSFORMS	12

Fourier transforms: Definitions, properties – Transform of elementary functions, Dirac Delta functions – Convolution theorem, Parseval's identity – Solutions to partial differential equation: Heat equations, Wave equations, Laplace and Poisson's equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Define norms, inner products, probability, random processes, Little's formula and Fourier transform
CO2:	Describe the axioms of probability, random variables and queueing models
CO3:	Discuss singular values, Poisson processes, and Fourier transform of elementary functions.
CO4:	Solve matrices, linear system of equations and functions of Fourier transform in engineering field
CO5:	Apply the ideas of probability, random processes, queueing theory and Baye's theorem in engineering

REFERENCES:

1.	Richard Bronson, "Matrix Operations" Schaum's outline series, McGraw Hill, 2nd Edition,

	New York, 2011.
2.	Miller,S.L. and Childers D.G, "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2012.
3.	Spiegel. M.R., Schiller. J and Srinivasan. R.A, "Schaum's Outlines on Probability and Statistics, Tata McGraw Hill Edition, 4th Edition, 2012.
4.	Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M, "Fundamentals of Queueing Theory", 4th Edition, Wiley, 2013.
5.	SankaraRao. K, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd, New Delhi, 2013.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	2	2	2	-
CO2	-	-	-	1	-	-
CO3	-	-	2	2	2	-
CO4	-	-	2	2	2	-
CO5	-	-	-	1	-	-
CO	-	-	2	1.6	2	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse (An) Evaluate (Ev)
Unit-I: Linear Algebra	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO4	-
Unit-II: Probability And Random Variables	2	1 either or	1(2)-CO1	1(2)-CO2	1either or (16)-CO5	-
Unit-III: Random Processes	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO5	-
Unit-IV: Queueing Theory	2	1 either or	1(2)-CO1	1(2)-CO2	1either or (16)-CO5	-
Unit-V: Fourier Transforms	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO4	-
Total Qns.	10	5 either or	5(2)	5(2)	5 either or (16)	-
Total Marks	20	80	10	10	80	-
Weightage	20%	80%	10%	10%	80%	-

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	10	4	6	32	48
Weightage	10%	4%	6%	32%	48%

CU22102	MODERN DIGITAL COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss about various coherent and non-coherent communication receivers and its performance
- To estimate the effects of signalling through band limited channels and Equalization techniques
- To compare different channel models, channel capacity using different block coding techniques
- To summarize the basics of OFDM and CDMA technique.
- To perform error probability performance for various coding and decoding techniques.

UNIT I	COHERENT AND NON-COHERENT COMMUNICATION	9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – QAM modulation and demodulation Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; MDPSK-BER Performance Analysis. Carrier Synchronization Bit synchronization.

UNIT II	EQUALIZATION TECHNIQUES	9

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

UNIT III	BLOCK CODED DIGITAL COMMUNICATION	9

Architecture and performance – Binary block codes; – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Error Probability of linear block codes, Hamming; Maximum-Length, Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes

UNIT IV	CONVOLUTIONAL CODED DIGITAL COMMUNICATION	9

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

UNIT V	MULTICARRIER AND MULTIUSER COMMUNICATIONS	9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Spectral characteristics of multicarrier signals, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Differentiate coherent and non-coherent receivers and analyze their performance under AWGN channel conditions
CO2:	Illustrate the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI
CO3:	Determine the channel capacity and design various block coding techniques to combat channel errors
CO4:	Construct convolutional coders and analyze the performance of different decoding techniques
CO5:	Describe the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

REFERENCES:	
1	John G. Proakis and Masoud Salehi “Digital Communication”, Fifth Edition, Mc Graw Hill Publication, 2014
2	Simon Haykin, Adaptive Filter Theory, Pearson Prentice Hall, 5th edition, 2014
3	Bernard Sklar and Fredric Harris, “Digital Communications Fundamentals and Applications”, Third edition, Pearson Education, 2021.
4	Lathi B P and Zhi Ding, “Modern Digital and Analog communication Systems", Fifth edition, Oxford University Press, 2019.
5	Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications” Artech House Publication, 2001
6	Theodore S.Rappaport, ‘Wireless Communications”, 2nd edition, Pearson Education, 2002

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	1	-	-
CO4	2	1	2	2	-	-
CO5	2	2	2	2	-	-
CO	2	1.8	2	1.8	-	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Coherent and Non-coherent Communication	2	1either or	1(2)-CO1	1(2)-CO1 1 either or (16)-CO1	-	-
Unit-II: Equalization Techniques	2	1either or	2(2)-CO2	1 either or (16)-CO2	-	-
Unit-III: Block Coded Digital Communication	2	1either or	1(2)-CO3	1(2)-CO3	1either or (16)-CO3	-
Unit-IV: Convolutional Coded Digital Communication	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO3	-
Unit-V: Multicarrier And Multiuser Communications	2	1either or	2(2)-CO5	1 either or (16)-CO5	-	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-

Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22101	**STATISTICAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES:

- To introduce the basics of random signal processing
- To learn the concept of estimation and signal modeling
- To know about optimum filters and adaptive filtering and its applications

UNIT I **DISCRETE RANDOM SIGNAL PROCESSING** **9**

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Auto covariance and Cross covariance- Properties – White noise process – Wiener Khintchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations.

UNIT II **PARAMETER ESTIMATION THEORY** **9**

Principle of estimation and applications-Mathematical Estimation problem, -Properties of estimates-unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE)-Cramer Rao bound-Efficient estimators; Criteria of estimation: Methods of maximum likelihood and its properties; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, MAP estimation.

UNIT III **SPECTRUM ESTIMATION** **9**

Estimation of spectra from finite duration signals, Bias and Consistency of estimators - Non-Parametric methods: Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric Methods: AR, MA and ARMA spectrum estimation - Detection of Harmonic signals - Performance analysis of estimators. MUSIC algorithms

UNIT IV **SIGNAL MODELING AND OPTIMUM FILTERS** **9**

Introduction- Least square method – Pade approximation – Prony's method – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Wiener Filter -– MSE – State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

UNIT V **ADAPTIVE FILTERS** **9**

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications: Noise cancellation, channel equalization, echo canceller, Adaptive Recursive Filters: RLS adaptive algorithm, Exponentially weighted RLS-sliding window RLS. Matrix inversion Lemma, Initialization, tracking of nonstationarity.

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation of Standard discrete time sequences (Unit Impulse, Unit Step, Unit Ramp, Sinusoidal and exponential signals) and carrying out arithmetic operations and plot the results.
2. Generation of random sequences satisfying the given probability distributions such as Uniform, Gaussian, Rayleigh and Rician.

3. Estimation of power spectrum of the given random sequence using Nonparametric methods (Bartlett, Welch and Blackman Tukey).	
4. Estimation of power spectrum of the given random sequence using parametric methods (AR, MA and ARMA).	
5. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using LMS Algorithm.	
6. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using RLS Algorithm.	
7. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using RLS Algorithm.	
TOTAL: 75 PERIODS	
COURSE OUTCOMES:	
On the successful completion of the course, students will be able to.	
CO1:	Explain the basic discrete time random processes
CO2:	Interpret the methods to detect signals and to estimate parameters from frequency spectra.
CO3:	Select signal models suitable for modelling random sequences.
CO4:	Apply optimum filters for signal processing
CO5:	Develop adaptive filters for various applications
REFERENCES:	
1	Monson. H. Hayes, Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996 (Reprint 2008).
2	Simon Haykin, Adaptive Filter Theory, Pearson Prentice Hall, 5th edition, 2014
3	D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, Artech House Publishers, 2005.
4	Steven. M. Kay, Modern Spectral Estimation, Theory and Application, Pearson India, 2009.
5	A.Veloni, N I. Miridakis, E Boukouvala, Digital and Statistical SignalProcessing, CRCPress, 2019.
6	S Nandi, D Kundu, Statistical Signal Processing- Frequency Estimation, Springer Nature Singapore, 2nd edition, 2020.
7	M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Statistical Signal Processing with Applications, PHI, 1996.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	-	1	1	-
CO2	1	1	1	1	1	-
CO3	2	1	1	2	2	-
CO4	2	2	2	2	2	-
CO5	2	2	2	2	2	-
CO	1.6	1.4	1.2	1.6	1.6	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Discrete Random Signal Processing	2	1either or	1(1)-CO1	1(1)-CO1 1either or (16)-CO1	-	-
Unit-II: Parameter EstimationTheory	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Spectrum Estimation	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Signal Modeling And Optimum Filters	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Adaptive Filters	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	6(2)	4(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	12	56	32	-
Weightage	20%	80%	12%	56%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22103	DIGITAL COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To study & measure the performance of digital communication systems
- To provide a comprehensive knowledge of Wireless Communication
- To learn about the design of digital filter and its adaptive filtering algorithm

LIST OF EXPERIMENTS (MATLAB/SCILAB/LABVIEW)

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation & detection of binary digital modulation techniques using SDR
2. Spread Spectrum communication system-Pseudo random binary sequence generation Baseband DSSS
3. MIMO system transceiver design using MATLAB/SCILAB/LABVIEW
4. Performance evaluation of simulated CDMA system
5. Channel Coder/decoder design (block codes / convolutional codes/ turbo codes)
6. OFDM transceiver design using MATLAB /SCILAB/LABVIEW
7. Channel equalizer design using MATLAB (LMS, RLS algorithms)
8. Design and Analysis of Spectrum Estimators (Bartlett, Welch) using MATLAB
9. BER performance Analysis of M-ary digital Modulation Techniques (coherent & non coherent) in AWGN Environment using MATLAB/SCILAB/LABVIEW
10. Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm using MATLAB/SCILAB/LABVIEW
11. Noise / Echo cancellation using MATLAB (LMS / RLS algorithms).
12. Study of synchronization (frame, bit, symbol)
13. Wireless channel characterization

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Generate and detect digital communication signals of various modulation techniques using MATLAB
CO2:	Implement the adaptive filtering algorithms
CO3:	Apply mathematical formulation to analyze spectrum estimation of a signal and bit rate determination of a transmission link
CO4:	Analyze the performance of optimization algorithms for equalizing the channel or noise/echo cancellation
CO5:	Evaluate cellular mobile communication technology and propagation model

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	-
CO2	2	-	2	2	2	-
CO3	2	-	2	2	2	-
CO4	2	-	2	2	2	-
CO5	2	-	2	2	2	-
CO	2	-	2	2	2	-

CU22104	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

- Selecting a subject, narrowing the subject into a topic
- Stating an objective
- Collecting the relevant bibliography (atleast 15 journal papers)
- Preparing a working outline
- Studying the papers and understanding the authors contributions and critically analysing each paper
- Preparing a working outline
- Linking the papers and preparing a draft of the paper
- Preparing conclusions based on the reading of all the papers
- Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained. Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularlyin your area 7. Attach a call for papers (CFP) from your area.	3rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to	4th week	6% (the list of standard papers and reason for selection)

	each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, •Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? 5 th week 8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) •What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others?	5^{th} week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	• What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th week & 15th week	10% (based on presentation and Viva-voce)

RM22101	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2

UNIT I	RESEARCH DESIGN	6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II	DATA COLLECTION AND SOURCES	6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III	DATA ANALYSIS AND REPORTING	6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV	INTELLECTUAL PROPERTY RIGHTS	6

Intellectual Property — The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V	PATENTS	6

Patents — objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 30 PERIODS

REFERENCES:

1.	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2.	Kothari C R, Gaurav Garg, "Research Methodology- Methods and Techniques" New Age International Publishers, 2019.
3.	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4.	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tool & techniques", Wiley, 2007
5.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember(Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
			No. of Qns. (marks) and CO			
Unit-I: Research Design	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Data Collection And Sources	2	1 either or	2(2) - CO2		1 either or (16) — CO2	-
Unit-III: Data Analysis And Reporting	2	1 either or	1(2) — CO3	1(2) — CO3		1 either or (16) — CO3

Unit-IV: Intellectual Property Rights	2	1 either or	2(2) - CO4		1 either or (16) — CO4	-
Unit-V: Patents	2	1 either or	1(2) – CO5	1(2) — CO5 1 either or (16) — CO5	-	
Total Qns. RESEARCH METHODOLOGY	10	5 either or	8(2)	2(2) 2 either or (16)	2 either or (16)	-
Total Marks	20	80	16	36	32	16
Weightage	20%	80%	16%	36%	32%	16%

Weightage for COs					
	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER II

CU22204	**ADVANCED WIRELESS COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn the concepts of wireless communication.
- To know about the various propagation methods, Channel models, capacity calculations
- To know about multiple antennas and multiple user techniques used in the mobile communication.

UNIT I	**WIRELESS CHANNEL PROPAGATION AND MODEL**	**9**

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, 5G Channel model requirements and Measurements, propagation scenarios, METIS channel models, Map-based model, stochastic model

UNIT II	**CAPACITY OF WIRELESS CHANNELS**	**9**

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of MISO, SIMO systems

UNIT III	**DIVERSITY**	**9**

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT IV	**MIMO COMMUNICATIONS**	**9**

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding : STBC,STTC, Spatial Multiplexing and BLAST Architectures

UNIT V	**MULTI USER SYSTEMS**	**9**

Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, MIMO-MUD Application of convex optimization to wireless design .

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Relate the wireless channel characteristics and identify appropriate channel models
CO2:	Illustrate the mathematics behind the capacity calculation under different channel conditions
CO3:	Summarize the implication of diversity combining methods and the knowledge of channel
CO4:	Apply the concepts in MIMO Communications
CO5:	Examine multiple access techniques and their use in different multi-user scenarios.
REFERENCES:	
1	David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, First Edition, 2012
2	Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2012.
3	Harry R. Anderson, "Fixed Broadband Wireless System Design", John Wiley, India, 2003.
4	Andreas.F. Molisch, "Wireless Communications", John Wiley, India, Second Edition 2010.
5	Sergio Verdu ― Multi User Detection‖ Cambridge University Press, 1998.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	1	1
CO2	2	2	1	2	1	1
CO3	2	2	1	2	1	1
CO4	2	2	1	2	1	1
CO5	2	2	1	2	1	1
CO	2	2	1	2	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Wireless Channel Propagation And Model	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Capacity Of Wireless Channels	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Diversity	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: MIMO Communications	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-

Unit-V: Multi User Systems	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22201	**MICROWAVE CIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES:

- To familiarize different transmission lines used at Microwave frequencies
- To design impedance matching networks using lumped and distributed elements
- To design and analyze different microwave components
- To use SMITH chart to analyze the region of stability and instability for designing amplifiers and oscillators
- To simulate and to test the microwave components under laboratory conditions

UNIT I **PLANAR TRANSMISSION LINES AND COMPONENTS** **9**

Review of Transmission line theory – S parameters-Transmission line equations – reflection coefficient – VSWR – Microstrip lines: Structure, waves in microstrip, Quasi-TEM approximation, Coupled lines: Even mode and odd mode analysis – Microstrip discontinuities and components – Strip line – Slot line – Coplanar waveguide – Filters – Power dividers and Couplers

UNIT II **IMPEDANCE MATCHING NETWORKS** **9**

Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements

UNIT III **MICROWAVE AMPLIFIER AND OSCILLATOR DESIGN** **9**

Introduction to Amplifier Design – Stability considerations in active networks – Gain Consideration in Amplifiers – Single Stage Amplifier Design- Noise Consideration in active networks – Broadband Amplifier design – Oscillators: Oscillator versus Amplifier Design – Oscillation conditions

UNIT IV **MIXERS AND CONTROL CIRCUITS** **9**

Mixer Types – Conversion Loss – SSB and DSB Mixers – Design of Mixers: Single Ended Mixers – Single Balanced Mixers – Sub Harmonic Diode Mixers, Microwave Diodes, Phase Shifters – PIN Diode Attenuators

UNIT V **MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES** **9**

Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology – Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

TOTAL : 45 PERIODS

PRACTICAL EXERCISES:	30 PERIODS
1.	Study of transmission line parameters – Impedance analysis
2.	Design of impedance matching networks
3.	Design of low pass and high pass filter
4.	Design of band-pass and band-stop filters
5.	Design of branch line couplers
6.	Design of phase shifters
7.	Design of Mixers
8.	Design of Power dividers
COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Illustrate the concepts of planar transmission line
CO2:	Demonstrate simulations, fabricate and test microwave devices
CO3:	Construct stability analysis of amplifiers and oscillators at microwave frequencies
CO4:	Develop impedance matching circuits using LC components and stubs
CO5:	Analyze microwave components
	TOTAL: 75 PERIODS

REFERENCES:

1	Jia Sheng Hong, M. J. Lancaster, "Microstrip Filters for RF/Microwave Applications", John Wiley & Sons, 2001
2	David M. Pozar, "Microwave Engineering", II Edition, John Wiley & Sons, 4th edition 2012
3	Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition,2001
4	Thomas H.Lee, "Planar Microwave Engineering", Cambridge University Press, 2004
5	Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education, II Edition 2002

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2	1	1	1
CO2	1	1	2	1	1	1
CO3	1	1	2	1	1	1
CO4	1	1	2	1	1	1
CO5	1	1	2	1	1	1
CO	1	1	2	1	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Planar Transmission	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-

Lines and Components						
Unit-II: Impedance Matching Networks	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Microwave Amplifier and Oscillator Design	2	1either or	1(2)-CO3	1(2)-CO3	1either or (16)-CO3	-
Unit-IV: Mixers and Control Circuits	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Microwave IC Design and Measurement Techniques	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 2 either or (16)	3 either or (16)	-
Total Marks	20	80	14	38	48	
Weightage	20%	80%	14%	38%	48%	

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22202	**RADIATING SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES:

- To understand Antenna basics
- To learn about Antenna arrays and their characteristics
- To study about operating Antennas
- To familiarize with modern Antennas and Measurement Techniques
- To learn about recent trends in Antenna Design

UNIT I	**ANTENNA FUNDAMENTALS & WIRE ANTENNAS**	**9**

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas — Mobile phone antenna-base station, hand set antenna Antenna fundamental parameters – Radiation integrals – Radiation from surface and line current distributions – dipole, monopole, loop antenna

UNIT II	**ANTENNA ARRAYS**	**9**

Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Linear array synthesis techniques – Binomial and Chebyshev distributions; Two dimensional uniform arrays; phased array antennas, switched beam and adaptive arrays, Mutual Coupling in

Finite Arrays.		
UNIT III	**APERTURE ANTENNAS**	**9**
Field equivalence principle, Radiation from Rectangular and Circular apertures, Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage. Radiation Mechanism and Excitation techniques, Microstrip dipole; Patch, Rectangular patch, Circular patch – Microstrip array and feed network; Lens Antennas.		
UNIT IV	**MODERN ANTENNAS & MEASUREMENT TECHNIQUES**	**9**
Base station antennas, PIFA – Antennas for WBAN – RFID Antennas – Automotive antennas, MIMO Antennas, smart antennas – Antenna impedance and radiation pattern measurements		
UNIT V	**RECENT TRENDS IN ANTENNA DESIGN**	**9**
UWB antenna arrays – Vivaldi antenna arrays – Artificial magnetic conductors/High impedance surfaces – Antennas in medicine – Plasma antennas – Antennas for millimeter wave communication - optimization techniques – Numerical methods.		
45 PERIODS		
PRACTICAL EXERCISES:	**30 PERIODS**	
USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:		
1	Antenna Radiation Pattern measurement	
2	Measurement of S parameters for a) Inductor b) Capacitor c) impedance matching circuits, filters using network analyzer	
3	Design of $\lambda/2$, $\lambda/4$ micro strip transmission line	
4	Characteristics of Micro strip patch antenna	
5	MIMO system transceiver design using MATLAB	
TOTAL: 75 PERIODS		
COURSE OUTCOMES:		
Upon completion of the course, the students will be able to		
CO1:	Explain the fundamentals of wire antennas, antenna arrays and aperture antennas.	
CO2:	Identify the antennas specific to the design and applications.	
CO3:	Analyse the challenges associated in designing antennas based on different technologies.	
CO4:	Categorize various modern antennas and measurement techniques.	
CO5:	Examine the need for optimizing in antenna design and the methodologies for the same.	
REFERENCES:		
1	Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 4th Edition,2015.	
2	Frank B. Gross, "Frontiers in Antennas", Mc Graw Hill, 2011.	
3	S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Springer Publications, 2nd Edition, 2010.	
4	Krauss.J.D, "Antennas", John Wiley and sons, New York, 3rd Edition, 2006.	
5	I.J. Bahl and P. Bhartia, "Microstrip Antennas", Artech House,Inc.,1980	
6	W.L.Stutzman and G.A.Thiele, "Antenna Theory and Design", John Wiley& Sons Inc., 3rd Edition, 2012.	
7	Robert J. Mailloux," Phased Array Antenna Handbook", Artech House,3rd Edition,2017.	
8	Clive Parini, Stuart Gregson and John McCormick,"Theory and Practice of Modern Antenna Range Measurements", IET Digital Library, 2014.	

9	Praveen Kumar Malik, Pradeep Kumar and Dushyant Kumar Singh, "Smart Antennas: Recent Trends in Design and Applications",Vol.2,Bentham books,2021.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	2	-	2	2	2	2
CO3	2	-	2	2	2	2
CO4	2	-	2	2	2	2
CO5	2	-	2	2	2	2
CO	2	-	2	2	2	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Antenna fundamentals &Wire Antennas	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Antenna Arrays	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Aperture Antennas	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Modern Antennas & Measurement Techniques	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Recent trends in Antenna Design	2	1either or	1(2)-CO5	1(2)-CO5	1eitheror (16)-CO5	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22203	MACHINE LEARNING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To outline different aspects of unsupervised learning and reinforcement learning
- To outline the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	9

Machine Learning - Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory.

UNIT II	SUPERVISED LEARNING	9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest.

UNIT III	UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING	9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning..

UNIT IV	PROBABILISTIC METHODS FOR LEARNING	9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

UNIT V	NEURAL NETWORKS AND DEEP LEARNING	9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases.

45 PERIODS

SUGGESTED ACTIVITIES:

1	Give an example from our daily life for each type of machine learning problem
2	Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3	Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4	Outline 10 machine learning applications in healthcare
5	Give 5 examples where sequential models are suitable.
6	Give at least 5 recent applications of CNN
	PRACTICAL EXERCISES: 30 PERIODS
1.	Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters
2.	Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1).

	Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3.	Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifer to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4.	In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5.	Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset
6.	Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classification dataset
7.	Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
	a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
	b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
	c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
	d. You must properly provide references to any work that is not your own in the write-up.
	e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.
List of Projects (datasets available)	
1.	Sentiment Analysis of Product Reviews
2.	Stock Prediction
3.	Sales Forecasting
4.	Music Recommendation
5.	Handwriting Digit Classification
6.	Fake News Detection
7.	Sports Prediction
8.	Object Detection
9.	Disease Prediction
	TOTAL: 75 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Describe the problems associated with each type of machine learning.
CO2:	Summarize a decision tree and a random forest for an application
CO3:	Demonstrate Probabilistic Discriminative and Generative algorithms for an application
CO4:	Analyze a tool to implement typical clustering algorithms for different types of applications
CO5:	Design applications suitable for different types of Machine Learning

REFERENCES:

1	Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2	Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3	Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4	Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5	Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6	Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015.
7	Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007
8	Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10	Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)
11	François Chollet, "Deep Learning with Python", 2nd Edition,2021

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	1	2
CO2	2	2	2	2	1	2
CO3	2	1	2	2	2	2
CO4	2	2	2	2	2	1
CO5	2	2	1	1	2	2
CO	2	1.8	1.8	1.8	1.6	1.8

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-

and Mathematical Foundations						
Unit-II: Supervised Learning	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: Unsupervised Learning and Reinforcement Learning	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Probabilistic Methods for Learning	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Neural Networks and Deep Learning	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	6(2)	4(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	12	56	32	-
Weightage	20%	80%	12%	56%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22205	WIRELESS COMMUNICATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods, wireless and AWGN channel characterization, application of adaptive filter algorithms for communication system design, coding and modulation design, synchronization aspects and the overall baseband system design.
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To enable the student to appreciate the practical aspects of baseband system design and understand the associated challenges.

LIST OF EXPERIMENTS:

1.	Spectral Characterization of communication signals (using Spectrum Analyzer)
2.	Design and Analysis of Spectrum Estimators (Bartlett , Welch)
3.	Design and analysis of digital modulation techniques on an SDR platform
4.	Carrier and Symbol timing Synchronization using SDR platform
5.	CDMA signal generation and RAKE receiver design using DSP/MATLAB/ SIMULINK
6.	Design and performance analysis of error control encoder and decoder (Block and Convolutional Codes)
7.	Wireless Channel equalizer design using DSP (ZF / LMS / RLS)
8.	Wireless Channel Estimation and Diversity Combining
9.	Design and simulation of Microstrip patch antenna
10.	Analysis of Antenna Radiation Pattern and measurement

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Design and conduct experiments to demonstrate the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods.
CO2:	Apply communication engineering principles and design tools and will be well practiced in design skills.
CO3:	Record comprehensively and report the measured data, write reports, communicate research ideas and do oral presentations effectively.
CO4:	Analyze and interpret the experimental measurement data and produce meaningful conclusions
CO5:	Evaluate the baseband system design and understand the associated challenges.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	2	-
CO2	2	1	2	1	2	-
CO3	2	1	2	1	2	-
CO4	2	1	2	1	2	-
CO5	2	1	2	1	2	-
CO	2	1	2	1	2	-

RM22201	RESEARCH TOOL LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To familiarize the fundamental concepts/techniques for Project Management
- To familiarize the journal paper formatting using suitable Software
- To familiarize the software for literature review and Bibliography
- To find the plagiarism percentage of article contents
- To prepare a quality research report and the presentation

LIST OF EXPERIMENTS:

1.	Use of tools / Techniques for Research - Project management -Microsoft Project / Microsoft OneNote / Asana.
2.	Hands on training related to software for paper formatting like LaTeX / MS Office
3.	Design a layout of a research paper - Guidelines for submitting the research paper - Review process -Addressing reviewer comments.
4.	Introduction to Data Analysis Software - Origin SPSS, ANOVA etc.,
5.	Introduction to software for detection of plagiarism – Urkund, Turniton
6.	Preparing bibliography / Different reference formats. – EndNote, Mently
7.	Format of project report - Use of quotations - Method of transcription- Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures
8.	Introduction to Microsoft Excel –for research analysis
9.	Presentation using PPTs.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1:	List the various stages in research and develop systematic planning of project stages.
CO2:	Write a journal paper and formulate as per the standard journal format (Applying)
CO3:	Develop a literature review and relevant references for a research problem using suitable software.
CO4:	Determine the plagiarism of the article/report content by using the Software (Applying)
CO5:	Compile a research report and the presentation (Applying)

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	-	-	-	-
CO2	-	2	-	-	-	-
CO3	1	2	1	-	-	-
CO4	-	2	1	-	-	-
CO5	-	2	1	-	-	-
CO	1.5	2	1	-	-	-

PROFESSIONAL ELECTIVES

SEMESTER I, PROFESSIONAL ELECTIVE – I

AE22111	APPLICATIONS SPECIFIC INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To analyze the issues and tools related to ASIC/FPGA design and implementation.
- To understand basics of System on Chip and Platform based design.

UNIT I	INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN	9

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell-Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.

UNIT II	PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS	9

Anti-fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA –Altera FLEX -Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

UNIT III	PROGRAMMABLE ASIC ARCHITECTURE	9

Architecture and configuration of Spartan / Cyclone and Virtex / Stratix FPGAs — Micro-Blaze /Niosbased embedded systems – Signal probing techniques.

UNIT IV	LOGIC SYNTHESIS, SYSTEM PARTITIONING,PLACEMENT AND ROUTING	9

Logic synthesis - System partitioning- ASIC floor planning- placement and routing – power and clocking strategies.

UNIT V	HIGH PERFORMANCE ALGORITHMS FOR ASICs/ SOCs SOC CASE STUDIES	9

DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators.CaseStudies: Digital camera, SDRAM, High speed data standards

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Recall the CMOS logics, ASIC library and programmable ASICs
CO2:	Explain ASIC design flow, programmable ASIC cells and architectures
CO3:	Describe I/O cells, interconnects Tentative and high performance algorithms for ASICs
CO4:	Demonstrate logic synthesis, system partitioning, placement and routing
CO5:	Investigate new developments in SOC and low power design

REFERENCES:

1	Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
2	Jose E. France, YannisTsividis, "Design of Analog - Digital VLSI Circuits for Telecommunicationand Signal Processing", Prentice Hall, 1994.
3	M.J.S.Smith, " Application - Specific Integrated Circuits", Pearson,2003.
4	Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing ", McGraw Hill, 1994.

5	Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, "FPGA-based Implementation of Signal Processing Systems", Wiley, 2008.
6	Steve Kilts, "Advanced FPGA Design," Wiley Inter-Science,2007

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	1	1
CO2	2	-	2	2	1	1
CO3	2	-	2	2	1	1
CO4	2	-	2	2	1	1
CO5	2	-	2	2	1	1
CO	2	-	2	2	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To ASICs, CMOS Logic and ASIC Library Design	2	1 either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Programmable ASICs, Programmable ASIC Logic Cells and Programmable ASIC I/O Cells	2	1 either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Programmable ASIC Architecture	2	1 either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Logic Synthesis, System Partitioning, Placement and Routing	2	1 either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: High Performance Algorithms For ASICs/SOCs.	2	1 either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5	-	-

Case Studies						
Total Qns.	10	5 either or	7(2)	3(2) 5 either or (16)	-	-
Total Marks	20	80	14	86	-	-
Weightage	20%	80%	14%	86%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AE22112	**ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I	**INTRODUCTION & SOURCES OF EM INTERFERENCE**	**9**

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment

UNIT II	**EM SHIELDING**	**9**

Introduction – Shielding Theory- LF Magnetic shielding, PCB level Shielding Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures.

UNIT III	**INTERFERENCE CONTROL TECHNIQUES**	**9**

Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices

UNIT IV	**EMC STANDARDS, MEASUREMENTS AND TESTING**	**9**

Need for standards – Civilian EMC standards – Military standards- The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments

UNIT V	**EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES**	**9**

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications

TOTAL: 45 PERIODS

SUGGESTED ACTIVITIES:

1. Investigate various case studies related to EMIC. Example: Chernobyl Disaster in 1986.
2. Develop some understanding about the design of EM shields in electronic system design and

packaging	
COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Demonstrate knowledge of the various sources of electromagnetic interference
CO2:	Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
CO3:	Explain the EMI mitigation techniques of shielding and grounding
CO4:	Explain the need for standards and EMC measurement methods
CO5:	Discuss the impact of EMC on wireless and broadband technologies
REFERENCES:	
1	Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2	Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition, 2008.
3	Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition, 2010.
4	Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork, 2009.
5	Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	1	1	2
CO2	2	2	2	1	1	2
CO3	2	2	2	1	1	2
CO4	2	2	2	1	1	2
CO5	2	2	2	1	1	2
CO	2	2	2	1	1	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction & Sources of EM Interference	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: EM Shielding	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III:	2	1either or	1(2)-CO3	1(2)-CO3	-	-

Interference Control Techniques				1either or (16)-CO3		
Unit-IV: EMC Standards, Measurements and Testing	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: EMC Considerations in Wireless and Broadband Technologies	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5	-	-
Total Qns.	10	5either or	7(2)	3(2) 5 either or (16)	-	-
Total Marks	20	80	14	86	-	-
Weightage	20%	80%	14%	86%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22111	**ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn M2M developments and satellite applications
- To understand Satellite Communication in Ipv6 Environment

UNIT I	**OVERVIEW OF SATELLITE COMMUNICATION**	**9**

Overview of satellite communication and orbital mechanics,placement of satellite in geostationary orbit, Link budget Parameters, Link budget calculations, Auxiliary Equation.

UNIT II	**DEVELOPMENTS AND SATELLITE APPLICATIONS**	**9**

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support- Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators-Ultra HD Video/TV and Satellite Implications-High Throughput Satellites (HTS) and Ka/Ku Spot Beam Technologies-Aeronautical, Maritime and other Mobility Services

UNIT III	**SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT**	**9**

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence--Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 – Impact of IPv6 on Satellite Network architecture and services-Detailed transitional plan- IPv6 demonstration over satellites.

UNIT IV	**SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM**	**9**

Over view of Radio and Satellite Navigation, GPS Principles, GPS constellation, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data, GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS and Galileo.		
UNIT V	**DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS**	**9**
Introduction – Functional description - Design procedure and performance criterion-Mars exploration Rover- Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance. Mangalyaan Mission - Mission and space craft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Explain the basics of Satellite communication, navigation and global positioning system.
CO2:	Identify the developments, applications and inter planetary missions in Satellite communication.
CO3:	Analyze IPV6 environment, deep space networks and inter planetary missions.
CO4:	Examine different attenuation mechanisms affecting the satellite link design and the different communication, sensing and navigational applications of satellite.
CO5:	Evaluate the implementation aspects of existing satellite based systems.

REFERENCES:

1	Adimurthy.V,"Concept design and planning of India's first interplanetary mission" Current Science, VOL. 109, NO. 6, 1054 25 September 2015
2	Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
3	Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2015
4	Scott Madry," Global Navigation Satellite Systems and Their Applications", Springer, 2015.
5	Daniel Minoli, "Satellite Systems Engineering in an IPv6 Environment", CRC Press, First Edition, 2009.
6	Jim Taylor," Deep Space Communications",Wiley Online Library,1st Edition,2016.
7	Daniel Minoli," Satellite Systems Engineering in an IPv6 Environment",1st Edition, Auerbach Publications,2019.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	2	2
CO2	2	-	2	2	2	2
CO3	2	-	2	2	2	2
CO4	2	-	2	2	2	2
CO5	2	-	2	2	2	2
CO	2	-	2	2	2	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Overview of Satellite Communication	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Developments and Satellite applications	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Satellite Communication in Ipv6 Environment	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Satellite navigation and Global Positioning System	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Deep Space Networks and Inter Planetary Missions	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22112	**HIGH SPEED SWITCHING AND NETWORKING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To explore the various space division switches
- To enable the various network performance analysis
- To get the clear idea about the various multimedia application
- To get a clear idea about the traffic and Queuing systems.

- Interpret the basics of security management and the various attacks & its counter measures

UNIT I	SWITCHING ARCHITECTURES	9

Shared medium switches – Shared memory switches – Space division switches – Cross bar based switching architecture – Input queued, Output queued and Combined input-output queued switches – Non blocking and blocking cross bar switches – Banyan networks – Batcher Banyan networks –Optical switches – Unbuffered and buffered switches – Buffering strategies – Optical packet switches and Optical burst switches – MEMS optical switches

UNIT II	NETWORK PERFORMANCE ANALYSIS	9

Objectives and requirements for Quality of Service (QoS) in high performance networks. Architecture of high performance networks (HPN), design issues, protocols for HPN, VHF backbone networks, virtual interface architectures, virtual interface for networking, High-speed switching and routing - internet and PSTN IP switching techniques, SRP protocols, SRP authentication, and key exchange, comparison of TCP/IP, FTP, TELNET, queuing systems, network modeling as a graph

UNIT III	MULTIMEDIA NETWORKING APPLICATIONS	9

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP differentiated services

UNIT IV	PACKET QUEUES AND DELAY ANALYSIS	9

Littles theorem, Birth and Death process, queueing discipline- Control & stability -, Markovian FIFO queueing system, Non-markovian - PollaczekKhinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues – Burkes theorem and Jackson Theorem.

UNIT V	NETWORK SECURITY AND MANAGEMENT	9

Principles of cryptography – Elliptic-AES Authentication – integrity – key distribution and certification– Access control and: fire walls – DoS-attacks and counter measures – security in many layers.Infrastructure for network management – The internet standard management framework – SMI, MIB,SNMP, Security and administration – ASN.1.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Explain the fundamental concepts of the switching architecture.
CO2:	Interpret the basics of various protocols and QOS in the network performance.
CO3:	Explain the various types of multimedia networking application.
CO4:	Demonstrate the various delay analysis method involved in the processing of packets.
CO5:	Solve the fundamental issues involved in providing the security as well as the management

REFERENCES:

1	Achille Pattavina, “Switching Theory Architectures and performance in Broadband ATM networks”, John wiley & sons Ltd. New York, 2007.
2	Elhanany, Itamar, Hamdi and Mounir, ―High Performance Packet Switching Architectures‖, Springer 2007
3	Walrand .J. Varatya, “High Performance Communication Network”, Morgan Kaufmann – Harcourt Asia Pvt. Ltd., 2nd Edition, 2000
4	Fred Halsall and Lingana Gouda Kulkarni, “Computer Networking and the Internet”, Fifth Edition, Pearson Education, 2012.

5	Nader F.Mir, “Computer and Communication Networks”, Pearson Education, 2009.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	-	-
CO2	1	1	1	1	-	-
CO3	1	1	2	2	-	-
CO4	2	2	2	2	-	-
CO5	2	2	2	2	1	-
CO	1.4	1.4	1.6	1.6	1	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Switching Architectures	2	1either or	1(1)-CO1	1(1)-CO1 1either or (16)-CO1	-	-
Unit-II: Network Performance Analysis	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: Multimedia Networking Applications	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Packet Queues And Delay Analysis	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: Network Security And Management	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	10	74	16	-
Weightage	20%	80%	10%	74%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AE22115	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To classify various soft computing frame works.
- To be familiar with the design of neural networks, fuzzy logic, and fuzzy systems.
- To learn mathematical background for optimized genetic programming.
- Be exposed to neuro-fuzzy hybrid systems and its applications.
- To understand the various evolutionary optimization techniques.

UNIT I	FUZZY LOGIC	9

Introduction to Fuzzy logic - Fuzzy sets and membership functions- Operations on Fuzzy sets- Fuzzy relations, rules, propositions, implications, and inferences- Defuzzification techniques- Fuzzy logic controller design- Some applications of Fuzzy logic

UNIT II	ARTIFICIAL NEURAL NETWORKS	9

Supervised Learning: Introduction and how brain works, Neuron as a simple computing element, The perceptron, Backpropagation networks: architecture, multilayer perceptron, backpropagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories (BAM), RBF Neural Network. Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self-Organizing Computational Maps: Kohonen Network.

UNIT III	GENETIC ALGORITHM	9

Genetic algorithm- Introduction - biological background - Genetic basic concepts - operators – Encoding scheme – Fitness evaluation – crossover - mutation - Travelling Salesman Problem, Particle swam optimization, Ant colony optimization

UNIT IV	NEURO-FUZZY MODELING	9

Adaptive Neuro-Fuzzy Inference Systems (ANFIS) – architecture - Coactive Neuro-Fuzzy Modeling, framework, neuron functions for adaptive networks – Data Clustering Algorithms – Rule base Structure Identification –Neuro-Fuzzy Control – the inverted pendulum system.

UNIT V	CONVENTIONAL OPTIMIZATION TECHNIQUES	9

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization-gradient search method-Gradient of a function, steepest gradient-conjugate gradient, Newton's Method, Marquardt Method, Constrained optimization –sequential linear programming, Interior penalty function method, external penalty function method

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Summarize the application on different soft computing techniques like Fuzzy, GA and Neural network
CO2:	Explain Neuro-Fuzzy and Neuro-Fuzzy-GA expert system.
CO3:	Solve machine learning problems through Neural networks.
CO4:	Examine Neuro Fuzzy system for clustering and classification.
CO5:	Design optimization techniques to solve the real world problems.

REFERENCES:

1	J.S.R.Jang, C.T. Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, PHI / Pearson Education 2004.
2	Timothy J. Ross," Fuzzy Sets and Fuzzy Logic with Engineering Applications",4th

	Edition, An Indian Adaptation,2021.
3	Jang , Sun and Mizutani," Neuro-Fuzzy And Soft Computing: A Computational Approach To Learning And Machine Intelligence", 1st Edition, Pearson India,2015.
4	Daniel Graupe," Principles Of Artificial Neural Networks: Basic Designs to Deep Learning",4th Edition, World Scientific, 2020.
5	David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addisonwesley, 2009.
6	Himanshu Singh&Yunis Ahmed Lone," Deep Neuro-Fuzzy Systems With Python", Apress publishers, 2020.
7	Sivanandam," Introduction To Genetic Algorithms", Springer India, 2013.
8	George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications,PrenticeHall, 1995.
9	James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, andProgramming Techniques, Pearson Edn., 2003.
10	Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003.
11	Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	2	2	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	2	2
CO4	2	1	2	2	2	2
CO5	2	1	2	2	2	2
CO	2	1	2	2	2	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Fuzzy Logic	2	1either or	1(1)-CO1	1(1)-CO1 1either or (16)-CO1	-	-
Unit-II: Artificial Neural Networks	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: Genetic Algorithm	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV:	2	1either	1(2)-CO4	1(2)-CO4	-	-

Neuro-Fuzzy Modeling		or		1either or (16)-CO4		
Unit-V: Conventional Optimization Techniques	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	5(2)	5(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	10	74	16	-
Weightage	20%	80%	10%	74%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER II, PROFESSIONAL ELECTIVE – II

CU22211	**MULTIMEDIA COMPRESSION TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn the basics about compression algorithms related to multimedia components such as text, speech, audio, image and video.
- To study the principles, standards, and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To gain the importance of compression in multimedia processing applications.
- To develop image and audio compression techniques.
- To apply compression standards.

UNIT I	**ESSENTIALS OF COMPRESSION**	**9**

Introduction to multimedia system- Elements, Categories, Features, Applications, and Stages of multimedia Application Development- Graphics, Image and Video representations – Fundamental concepts of video, digital audio–Storage Requirements Of Multimedia Applications–Need For Compression-Taxonomy of compression Algorithms.

UNIT II	**TEXT COMPRESSION TECHNIQUES**	**9**

Elements of Information Theory-Entropy coding: Run length coding -Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Analysis/Synthesis Schemes - Dictionary techniques – LZW family algorithms- Word based compression - Dynamic Markov Compression

UNIT III	**IMAGE COMPRESSION TECHNIQUES**	**9**

Image Compression: Fundamentals — Compression Standards – Still image coding JPEG Standard – Sub-band coding – Wavelet transform for image coding– Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT IV	**AUDIO COMPRESSION TECHNIQUES**	**9**

Audio compression Techniques –μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive

encoding – Silence compression, Speech compression – Formant and CELP vocoders.		
UNIT V	**VIDEO COMPRESSION TECHNIQUES**	**9**
Video compression: Fundamentals, techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Content-Based Video Coding. ITU-T Video Coding Standards H.261 and H.263. Video Coding Standard--H.264/AVC. A New Video Coding Standard-- HEVC/H.265. Internet Video Coding Standard--IVC. MPEG Media Transport-DVI technology – DVI real time compression – Current Trends in Compression standards.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Develop basic compression algorithms familiar with the use of MATLAB and its equivalent open source environments.
CO2:	Construct image and audio compression techniques.
CO3:	Practice the basic audio compression standards.
CO4:	Analyze text compression techniques.
CO5:	Analyze different approaches of compression algorithms in multimedia related mini projects.

REFERENCES:

1	Khalid Sayood: Introduction to Data Compression", Morgan Kauffman Harcourt India, Fifth Edition,2017.
2	David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlag, New York, 2011.
3	Thomas m. Cover Joy a. Thomas, "Elements Of Information Theory", Wiley Second edition 2013.
4	Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards, Third Edition", CRC Press,2019.
5	Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, Springer Nature; 2nd ed. 2014.
6.	Mohammed Ghanbari, Standard Codecs: Image compression to Advanced Video Coding, Telecommunication Series, IET, 3rd edition, 2011.
7.	Peter Symes, Digital Video Compression, McGraw Hill, 2004
8.	Iain E.G. Richardson, H.264 and MPEG-4, Video Compression: Video Coding for Next generation Multimedia, John Wiley, 2003.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	1	1	1
CO2	2	2	2	1	1	1
CO3	2	2	2	1	1	1
CO4	2	2	2	1	1	1
CO5	2	2	2	1	1	1
CO	2	2	2	1	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Essentials of Compression	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Text Compression Techniques	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Image Compression Techniques	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Audio Compression Techniques	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Video Compression Techniques	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	
Weightage	20%	80%	14%	54%	32%	

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22212	**COGNITIVE RADIO NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Understand the fundamental concepts of cognitive radio networks.
- Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
- Understand the functions of MAC layer and Network layer and its various protocols
- Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading
- Interpret the basics of security management and the various attacks & its countermeasures

UNIT I	**INTRODUCTION TO COGNITIVE RADIO**	**9**

Cognitive Radio: Techniques and signal processing History and background, Cognitive radio cycle, Cognitive radio architecture, SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection, cyclo stationary and wavelet based sensing- problem formulation and performance analysis based on probability of detection Vs SNR,Cooperative sensing.		
UNIT II	**SPECTRUM SENSING AND TRADING**	**9**
Introduction –Spectrum Sensing – Multiband Spectrum Sensing – Sensing Techniques – Spectrum sensing in current wireless standards-Other algorithms – Comparison – Performance Measure & Design Trade-Offs : Receiver operating characteristics – Throughput Performance measure – Fundamental limits and trade-off. Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).		
UNIT III	**MAC PROTOCOLS AND NETWORK LAYER DESIGN**	**9**
Functionality of MAC protocol in spectrum access –classification –Interframe spacing and MAC challenges – QOS – Spectrum sharing in CRAHN –CRAHN models – CSMA/CA based MAC protocols for CRAHN – Routing in CRN– Control of CRN-Centralized and Distributed protocols – Geographical Protocol.		
UNIT IV	**DYNAMIC SPECTRUM ACCESS AND MANAGEMENT**	**9**
Spectrum broker, Dynamic spectrum access architecture- centralized dynamic spectrum access,distributed dynamic spectrum access, Inter- and intra-RAN dynamic spectrum allocation, Spectrum management, Spectrum sharing, Spectrum mobility issues.		
UNIT V	**TRUSTED COGNITIVE RADIO NETWORKS AND RESEARCH CHALLENGES**	**9**
Trust for CRN: Fundamentals – Models – Effects of Trust Management –-Security properties in CRN – Route Disruption attacks –Jamming attacks –PU Emulation attacks. Network layer and transport layer issues, cross layer design for cognitive radio networks, Challenges and open problem in CRN.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Explain the fundamental concepts of cognitive radio networks.
CO2:	Interpret the basics of various spectrum sensing techniques and algorithms.
CO3:	Demonstrate the functions of MAC layer and Network layer and its various protocols.
CO4:	Explain the fundamental issues regarding dynamic spectrum access, the radio-resource management and trading
CO5:	Solve the security threats in cognitive radio networks.

REFERENCES:

1	Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Hüseyin Arslan, Springer, ISBN 978-1-4020-5541-6 (HB), 2007.
2	Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.
3	Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
4	Cognitive Radio Technology", by Bruce A. Fette, Elsevier, ISBN 10: 0-7506-7952-2, 2006.
5	Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, "Cognitive Radio Communications and Networks - Principles and Practice", Elsevier Inc., 2010

6	Mohamed Ibnkahla, "Cooperative Cognitive Radio Networks-The Complete Spectrum Cycle"CRC Press, 2015.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	-	-
CO2	1	2	2	1	-	-
CO3	1	2	1	2	1	-
CO4	2	2	2	2	1	-
CO5	2	2	2	2	2	-
CO	1.4	1.8	1.6	1.6	1.3	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To Cognitive Radio	2	1either or	1(1)-CO1	1(1)-CO1 1either or (16)-CO1	-	-
Unit-II: Spectrum Sensing And Trading	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Mac Protocols And Network Layer Design	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Dynamic Spectrum Access And Management	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: Trusted Cognitive Radio Networks And Research Challenges	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	6(2)	4(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	12	72	16	-

Weightage	20%	80%	12%	72%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22213	**SPEECH PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To describe about speech production and fundamental parameters of speech.
- To demonstrate the speech modeling procedures and implementation issues.
- To examine text analysis and speech synthesis.
- To relate the time-frequency representation of speech signal and coding.

UNIT I	**FUNDAMENTALS OF SPEECH PROCESSING**	**9**

Introduction– Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II	**SPEECH SIGNAL REPRESENTATIONS AND CODING**	**9**

Overview of Digital Signal Processing – Speech production mechanism – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vocoders.

UNIT III	**SPEECH RECOGNITION**	**9**

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs –Autoregressive HMM– Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV	**TEXT ANALYSIS**	**9**

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation.

UNIT V	**SPEECH SYNTHESIS**	**9**

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Model speech production system and describe the fundamentals of speech.
CO2:	Extract and compare different speech parameters.
CO3:	Choose an appropriate statistical speech model for a given application.
CO4:	Design a speech recognition system.
CO5:	Use different text analysis and speech synthesis techniques.

REFERENCES:	
1	Ben Gold, Nelson Morgan and Dan Ellis, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2011
2	Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, Tentative 1999.
3	Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2002.
4	Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.
5	Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
6.	Steven W. Smith, "The Scientist and Engineer"s Guide to Digital Signal Processing", California Technical Publishing, 1997.
7.	Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2004

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	2	-	-
CO4	2	2	1	2	-	-
CO5	2	2	2	2	-	-
CO	2	2	1.8	2	-	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Fundamentals of Speech Processing	2	1either or	2(2)-CO1	1 either or (16)-CO1	-	-
Unit-II: Speech Signal Representations And Coding	2	1either or	1(2)-CO2	1(2)-CO2 1 either or (16)-CO2	-	-
Unit-III: Speech Recognition	2	1either or	2(2)-CO3	1 either or (16)-CO3	-	-
Unit-IV: Text Analysis	2	1either or	1(2)-CO4	1(2)-CO4 1 either or (16)-CO4	-	-

Unit-V: Speech Synthesis	2	1either or	2(2)-CO5	1 either or (16)-CO5	-	-
Total Qns. Title	10	5either or	8(2)	5 either or (16)	-	-
Total Marks	20	80	16	84	-	-
Weightage	20%	80%	16%	84%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22214	**ANALOG AND MIXED SIGNAL VLSI DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study the concepts of MOS large signal model and small signal model
- To understand the concepts of D/A conversion methods and their architectures
- To learn filters for ADC
- To study about the switched capacitor circuits
- Interpret the basics of security management and the various attacks & its counter measures

UNIT I	**INTRODUCTION AND BASIC MOS DEVICES**	**9**

Challenges in analog design-Mixed signal layout issues- MOS FET structures and characteristics large signal and small signal model of single stage Amplifier-Source follower Common gate stage – Cascode Stage – large and small signal analysis of differential amplifier with active load, pole-zero estimation, zero value time constant method, frequency response of CS, cascade and cascade amplifiers.

UNIT II	**SUBMICRON CIRCUIT DESIGN**	**9**

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements – Adders- OP Amp parameters and Design,

UNIT III	**DATA CONVERTERS**	**9**

Static and dynamic errors in DAC and ADC – ADC and DAC Specifications - Architectures & Characteristics of Sample and Hold Digital to Analog Converters- DAC- R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC.

UNIT IV	**SNR IN DATA CONVERTERS**	**9**

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC.

UNIT V	**SWITCHED CAPACITOR CIRCUITS**	**9**

Resistors, First order low pass Circuit, Switched capacitor Amplifier, Switched Capacitor Integrator – Design of flip around sample and hold circuit – pipelined ADC.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Describe the basic MOS devices characteristics and analyze their frequency responses
CO2:	Design submicron circuit.
CO3:	Apply his knowledge on the DAC and ADC conversions.
CO4:	Analyze the SNR in Data converters.
CO5:	Design and analyze switched capacitor circuits
REFERENCES:	
1	J. Jacob Wikner, Mikael Gustavsson, Nianxiong Tan "CMOS Data Converters for Communications" Springer, 2000.
2	Van de Plassche, Rudy J., "CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters" Springer, Second Edition 2011.
3	C. C. Enz and E. A. Vittoz, Charge-based MOS Transistor Modeling, Wiley, 2006.
4	A. Sedra, K. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2015.
5	P. Jespers, B. Murmann, Systematic Design of Analog CMOS Circuits, Cambridge, 2017.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	1	2
CO2	2	2	1	2	1	2
CO3	2	2	1	2	1	2
CO4	2	2	1	2	1	2
CO5	2	2	1	2	1	2
CO	2	2	1	2	1	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction and Basic MOS Devices	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Submicron Circuit Design	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Data Converters	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: SNR in Data Converters	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-

Unit-V: Switched Capacitor Circuits	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22215	WAVELETS AND SUBBAND CODING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn about different wavelet families & their applications.
- To study signal compression and sub-band coding

UNIT I	INTRODUCTION TO WAVELETS	9

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space.

UNIT II	MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM	9

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banksAnalysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured Tentative filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III	WAVELET SYSTEM DESIGN	9

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV	WAVELET FAMILIES	9

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V	WAVELET APPLICATIONS AND SIGNAL COMPRESSION	9

Denoising of Signals and Images, Image enhancement, Edge detection, Wavelet based feature extraction -Compression Systems Based on Linear Transforms - Speech and Audio Compression - Image Compression - Video Compression.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Understand the fundamental concepts of wavelet transforms
CO2:	Apprehend detailed knowledge about wavelet transform
CO3:	Understand system design using wavelets
CO4:	Compare different wavelet families
CO5:	Analyze signal compression and sub-band coding

REFERENCES:

1	C.Sidney Burrus, Ramesh Gopinath & Haito Guo, “Introduction to wavelets and wavelet transform”, Prentice Hall, 1998.
2	G.Strang and T.Nguyen, “Wavelet and filter banks”, Wesley and Cambridge Press.
3	Metin Akay, “Time frequency and wavelets in biomedical signal processing”, Wiley-IEEE Press, October 1997.

4	M.Vetterli and J. Kovacevic, “Wavelets and sub band coding”, Prentice Hall, 1995.
5	P.Vaidyanathan, “Multi rate systems and filter banks”, Prentice Hall 1993
6	Raguveer m Rao & Ajith S. Bopardikar, “Wavelet transforms – Introduction to theory and applications”, Addison Wesley, 1998
7	S.Mallet, “A Wavelet tour of Signal Processing”, Academic Press 1998

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	2	-	-
CO4	2	2	1	2	-	-
CO5	2	2	2	2	-	-
CO	2	2	1.8	2	-	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction to Wavelets	2	1either or	2(2)-CO1	1 either or (16)-CO1	-	-
Unit-II: Multiresolution Concept And Discrete Wavelet Transform	2	1either or	1(2)-CO2	1(2)-CO2 1 either or (16)-CO2	-	-
Unit-III: Wavelet System Design	2	1either or	1(2)-CO3	1(2)-CO3 1 either or (16)-CO3	-	-
Unit-IV: Wavelet Families	2	1either or	1(2)-CO4	1(2)-CO4 2either or (16)-CO4	-	-
Unit-V: Wavelet Applications and Signal Compression	2	1either or	2(2)-CO5	-	1 either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	14	70	16	-
Weightage	20%	80%	14%	70%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER II, PROFESSIONAL ELECTIVE – III

CU22221	**ULTRA WIDE BAND COMMUNICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To describe the fundamental concepts related to Ultra wide band
- To select the channel model for UWB.
- To analyse about UWB antennas and regulations.

UNIT I	**INTRODUCTION TO UWB**	**9**

History, Definition, FCC Mask, UWB features, Benefits and challenges, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

UNIT II	**UWB TECHNOLOGIES AND CHANNEL MODELS**	**9**

Impulse Radio-Complexity, Power Consumption, Security, IR Industry Standard Groups - Pulsed Multiband, Multiband OFDM, features: Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels Channel model: Impulse Response Modeling of UWB Wireless Channels- Modified Impulse Response Method, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling.

UNIT III	**UWB SIGNAL PROCESSING AND WIRLESS LOCATIONING**	**9**

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error, Locationing with OFDM.

UNIT IV	**UWB ANTENNAS**	**9**

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Link Budget for UWB System- Short Range Analysis of UWB Antennas - Design examples of broad band UWB antennas

UNIT V	**UWB APPLICATIONS AND REGULATIONS**	**9**

Ultra wideband receiver architecture, Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation in various countries , UWB Regulation in ITU, IEEE Standardization

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Explain the basic concepts of UWB and interference.
CO2:	Describe the features of multiband OFDM and channel models.
CO3:	Identify the modulation scheme and performance in UWB.
CO4:	Construct broad band UWB antennas using radiation mechanisms.

CO5:	Inspect various application of UWB and its standards.
REFERENCES:	
1	Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications"1st Edition, Springer Science & Business Media B.V. 2010.
2	Thomas Kaiser, Feng Zheng "Ultra Wideband Systems with MIMO", 1st Edition, John Wiley & Sons Ltd, New York, 2010.
3	W. Pam Siriwongpairat and K. J. Ray Liu, "Ultra-Wideband Communications Systems: Multiband OFDM approach" John Wiley and IEEE press, New York 2008.
4	Huseyin Arslan,Zhi Ning Chen,Maria-Gabriella Di Benedetto "Ultra Wideband Wireless communication" Wiley-Interscience; 1st edition 2006.
5	Robert Aielo and Anuj Batra," Ultra Wideband Systems Technologies and Applications", Elsevier, 2006.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	1	-	-
CO4	2	2	2	2	-	-
CO5	2	2	2	2	-	-
CO	2	2	2	1.8	-	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction to UWB	2	1either or	2(2)-CO1	1 either or (16)-CO1	-	-
Unit-II: Multi resolution Concept UWB Technologies And Channel Models	2	1either or	1(2)-CO2	1(2)-CO2 1 either or (16)-CO2	-	-
Unit-III: UWB Signal Processing And Wireless Locationing	2	1either or	1(2)-CO3	1(2)-CO3 1 either or (16)-CO3	-	-
Unit-IV: UWB Antennas	2	1either or	1(2)-CO4	1(2)-CO4 2either or (16)-CO4	-	-

Unit-V: UWB Applications And Regulations	2	1either or	2(2)-CO5	-	1 either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	14	70	16	-
Weightage	20%	80%	14%	70%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22222	**VLSI FOR WIRELESS COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To learn the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To design transmitters and power amplifiers for wireless communication.

UNIT I	**COMMUNICATION CONCEPTS**	**9**

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading– Standard Translation

UNIT II	**RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS**	**9**

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedancematching & Core amplifier.

UNIT III	**MIXERS**	**9**

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.

UNIT IV	**FREQUENCY SYNTHESIZERS**	**9**

PLL – Phase detector – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT)– Frequency synthesizer with fractional divider.

UNIT V	**TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS**	**9**

Transmitter back end design – Quadrature LO generator – Power amplifier design. case study: GSM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Describe the basic wireless communication concepts.
CO2:	Explain the parameters in receiver and design a low noise amplifier
CO3:	Apply knowledge on various types of mixers designed for wireless communication.
CO4:	Analyze the Phase Lock Loop and Voltage Controlled Oscillator.
CO5:	Design the transmitters and the power amplifiers for wireless communication.

REFERENCES:

1	Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.
2	B.Razavi ,"RF Microelectronics" , Prentice-Hall ,1998.
3	Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 19994.
4	Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design – Circuits & Systems", Kluwer Academic Publishers, 2000.
5	J. Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Pub., 1997.
6	Thomas H.Lee, "The Design of CMOS Radio – Frequency Integrated Circuits", Cambridge University Press ,2003
7	Veena S. Chakravarthi, "A Practical Approach to VLSI System on Chip (SoC) Design", 2022
8	Ibrahim A. Bello, Basel Halak,"Algorithms and VLSI Implementations of MIMO Detection", 2022

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	1	2
CO2	2	2	2	2	1	2
CO3	2	2	1	2	2	2
CO4	2	2	2	2	2	1
CO5	2	2	1	1	2	2
CO	2	2	1.4	1.8	1.6	1.8

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Communication Concepts	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Receiver Architecture & Low Noise Amplifiers	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-

Unit-III: Mixers	2	1either or	1(2)-CO3	1(2)-CO3	1eitheror (16)-CO3	-
Unit-IV: Frequency Synthesizers	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4		-
Unit-V: Transmitter Architectures & Power Amplifiers	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5		-
Total Qns. Title	10	5either or	6(2)	4(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	12	72	16	-
Weightage	20%	80%	12%	72%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22223	**MEMS and NEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the concepts of Micro Electro Mechanical devices.
- To know the fabrication process of microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of Quantum Mechanics and Nano systems

UNIT I	**OVERVIEW**	**9**

New trends in Engineering and Science: Micro and Nanoscale systems, introduction to design of MEMS and NEMS, MEMS and NEMS – applications, devices and structures. Materials for MEMS: Silicon, Silicon compounds, polymers, metals

UNIT II	**MEMS FABRICATION TECHNOLOGIES**	**9**

Microsystem Fabrication Processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin Film Depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching Techniques: Dry and Wet Etching, Electrochemical Etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-Like) Technology; Packaging: Microsystems Packaging, Essential Packaging Technologies, Selection of Packaging Materials.

UNIT III	**MICRO SENSORS**	**9**

MEMS Sensors: Design of Acoustic Wave Sensors, Resonant Sensor, Vibratory Gyroscope, Capacitive and Piezo Resistive Pressure Sensors- Engineering Mechanics Behind These Microsensors. Case Study: Piezo-Resistive Pressure Sensor.

UNIT IV	**MICRO ACTUATORS**	**9**

Design of Actuators: Actuation Using Thermal Forces, Actuation Using Shape Memory Alloys,

Actuation Using Piezoelectric Crystals, Actuation using Electrostatic Forces (Parallel Plate, Torsion Bar, Comb Drive Actuators), Micromechanical Motors and Pumps. Case Study: Comb Drive Actuators		
UNIT V	**ARCHITECTURE AND APPLICATIONS**	**9**
Architecture of MEMS – Requirements of nano systems - Development of nano electronics and structuring – Application of NEMS – Deposition of coatings – Three dimensional materials – Dewatering		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Discuss micro sensors
CO2:	Explain micro actuators
CO3:	Outline nanosystems and Quantum mechanics
CO4:	Design micro actuators for different applications
CO5:	Analyze atomic structures

REFERENCES:	
1	Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2006.
2	Marc Madou, "Fundamentals of Microfabrication", CRC Press 1997.
3	Stephen D. Senturia," Micro System Design", Kluwer Academic Publishers,2001
4	Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC
5	Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	2	2	-
CO2	2	-	1	2	2	-
CO3	2	-	1	2	2	-
CO4	2	-	1	2	2	-
CO5	2	-	1	2	2	-
CO	2	-	1	2	2	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Overview	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: MEMS	2	1either	1(2)-CO2	1(2)-CO2	-	-

Fabrication Technologies		or		1either or (16)-CO2		
Unit-III: Micro Sensors	2	1either or	1(2)-CO3	1(2)-CO3	1eitheror (16)-CO3	-
Unit-IV: Micro Actuators	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4		-
Unit-V: Architecture And Applications	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5		-
Total Qns.	10	5either or	6(2)	4(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	12	72	16	-
Weightage	20%	80%	12%	72%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22224	**ADVANCED ANTENNA DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the antenna radiation characteristics and arrays
- To enhance the student knowledge in the area of various antenna design.
- To enhance the student knowledge in the area of antenna for practical applications.
- To study the effect of mutual coupling on antennas
- To understand the concept of adaptive arrays.

UNIT I	**FUNDAMENTAL CONCEPTS**	**9**

Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

UNIT II	**THIN LINEAR ANTENNAS AND ARRAYS**	**9**

Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop, Antenna element spacing without grating lobes, Linear broadside array with non-uniform distributions, Gain of regularly spaced planar arrays with d = $\lambda/2$,.self and mutual impedance.

UNIT III	**SECONDARY APERTURE ANTENNAS SOURCES AND**	**9**

Magnetic currents, Duality, Images of electric and magnetic currents, electric and magnetic currents as sheet sources, Impressed and induced current sources, Induction and equivalence theorems, Field of a secondary or Huygens source, Radiation from open end of a coaxial line,

UNIT IV	EFFECT OF MUTUAL COUPLING ON ANTENNAS	9
Accounting for mutual effects for dipole array compensation using open-circuit voltages, compensation using the minimum norm formulation, Effect of mutual coupling- constant Jammers, Constant Signal, Compensation of mutual coupling- constant Jammers, Constant Signal, Result of different elevation angle		
UNIT V	**ADAPTIVE ARRAY CONCEPT**	**9**
Motivation of using Adaptive Arrays, Adaptive Array problem statement, Signal Environment, Array Element Spacing considerations, Array Performance, Concept of optimum Array Processing, Recursive Methods for Adaptive Error Processing		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Explain the fundamental concepts of antennas, arrays and secondary aperture antennas
CO2:	Identify the secondary sources, aperture, broadband and frequency independent antennas
CO3:	Apply the knowledge of mutual coupling on antennas, applications and numerical techniques
CO4:	Analyze the radiation pattern of linear antennas and the methods for adaptive error processing
CO5:	Discuss different elevation angles, auxiliary potential functions and fields of a secondary source

REFERENCES:

1	Balanis, C., Antennas, John Wiley and sons (2007) 3rd Edition.
2	G. T. Markov,"Antennas",MIR publishers,2022.
3	Milligan, Thomas A., Modern Antenna Design 2nd edition, IEEE press, Wiley Interscience(2005).
4	David B. Davidson, Computational Electromagnetics for RF and Microwave Engineering,Cambridge University Press 2005
5	Neelakanta, Perambur S., and Chatterjee, Rajeswari, Antennas for Information Super Skyways: An Exposition on Outdoor and Indoor Wireless Antennas, Research Studies Press Ltd.(2004).
6	David Hysell," Antennas and Radar for Environmental Scientists and Engineers", Cornell University, New York, 2018.
7	Godara, Lal Chand, Smart Antennas, CRC Press (2004).
8	Levin," The Theory of Thin Antennas and Its Use in Antenna Engineering", Bentham Science Publishers, 2013.
9	Munk, Ben A., Finite Antenna Arrays and FSS, John Wiley and Sons (2003).

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	2	-	2	2	2	2
CO3	2	-	2	2	2	2
CO4	2	-	2	2	2	2
CO5	2	-	2	2	2	2
CO	2	-	2	2	2	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Fundamental concepts	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Thin LinearAntennas and Arrays	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Secondary Sources and Aperture Antennas	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Effect of Mutual Coupling on Antennas	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Adaptive Array concept	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22225	mmWAVE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of Millimeter communication.
- To understand Millimeter wave devices and circuits.
- To recognize the various components of Millimeter wave Communications system.
- To study the MIMO millimeter wave systems
- To know the antenna design at Millimeter wave frequencies

UNIT I	INTRODUCTION	9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications

UNIT II	mmWAVE DEVICES AND CIRCUITS	9

Millimeter wave generation and amplification: Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless

UNIT III	mmWAVE COMMUNICATION SYSTEMS	9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, Millimeter wave design considerations.

UNIT IV	mmWAVE MIMO SYSTEMS	9

Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT V	ANTENNAS FOR MM WAVE SYSTEMS	9

Advanced beam steering and beam forming, mm wave design consideration, On-chip and in package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Describe the Millimeter wave characteristics and implementation challenges faced.
CO2:	Explain the components in Millimeter devices and circuits
CO3:	Develop his knowledge on the Modulation techniques for millimeter wave communications
CO4:	Examine with Millimeter wave technology
CO5:	Design antenna for Millimeter wave frequencies

REFERENCES:

1	K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011
2	Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

3	Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.
4	Manuel García Sanchez, "Millimeter-Wave (mmWave) Communications" Electronincs, March 2020.
5	Jaco du Preez, Saurabh Sinha,"State-of-the-Art of Millimeter-Wave Silicon Technology",Springer Cham, 2022.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	2	1	2
CO2	2	2	1	2	1	2
CO3	2	1	2	1	2	2
CO4	2	2	2	2	2	2
CO5	2	1	1	2	2	1
CO	2	1.4	1.6	1.8	1.6	1.8

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: mmWave Devices and Circuits	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: mm Wave Communication Systems	2	1either or	1(2)-CO3	1(2)-CO3	1either or (16)-CO3	-
Unit-IV: mmWave MIMO Systems	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4		-
Unit-V: Antennas For MM Wave Systems	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5		-
Total Qns. Title	10	5either or	6(2)	4(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	12	72	16	-
Weightage	20%	80%	12%	72%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20

Weightage	20%	20%	20%	20%	20%

SEMESTER III, PROFESSIONAL ELECTIVE – IV

CU22311	IMAGE PROCESSING AND VIDEO ANALYTICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To comprehend the relation between human visual system and machine perception and processing of digital images.
- To provide a detailed approach towards image processing applications like enhancement, and segmentation, and compression.
- To explore the integration principles of communication system working with different sampling rates.
- To analysis the fundamentals of digital image processing, image and video analysis.
- To present the mathematics and algorithms that underlies image analysis techniques.

UNIT I	DIGITAL IMAGE FUNDAMENTALS	9

Elements of visual perception, Image sensing and acquisition, Image sampling and Quantization, Some basic relationships between pixels, 2D image transforms-DFT, DCT, KLT, and SVD, Introduction to color image – RGB and HSI Models.

UNIT II	IMAGE ENHANCEMENT AND SEGMENTATION TECHNIQUES	9

Image Enhancement in Spatial Domain methods: Histogram Processing, Enhancement using arithmetic/logic operations, image smoothing and image sharpening in spatial domain, image smoothing and image sharpening in frequency domain, Image segmentation- pixel based, edge based and region based segmentation.

UNIT III	VIDEO PROCESSING AND MOTION ESTIMATION	9

Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations 2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding.

UNIT IV	INTRODUCTION: VIDEO ANALYTICS	9

Computer Vision: Challenges- Spatial Domain Processing – Frequency Domain Processing Background Modeling-Shadow Detection-Eigen Faces - Object Detection -Local Features-Mean Shift: Clustering, Tracking - Object Tracking using Active Contours – Tracking & Video Analysis Kalman filters, condensation, particle, Bayesian filters, hidden Markov models, change detection and model based tracking.

UNIT V	MOTION UNDERSTANDING	9

Motion estimation and Compensation-Block Matching Method, Motion Segmentation - Thresholding for Change Detection, Estimation of Model parameters - Optical Flow Segmentation-Modified Hough Transform Method- Segmentation for Layered Video Representation-Bayesian Segmentation -Simultaneous Estimation and Segmentation-Motion Field Model - Action Recognition - Low Level Image Processing for Action Recognition.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES:

1.	Perform basic operations on images like addition, subtraction etc.
2.	Plot the histogram of an image and perform histogram equalization.
3.	Implement segmentation algorithms.
4.	Perform video enhancement.
5.	Perform video segmentation.
6.	Perform image compression using lossy technique.
7.	Perform image compression using lossless technique.
8.	Perform image restoration.
9.	Convert a colour model into another.
10.	Calculate boundary features of an image.
11.	Calculate regional features of an image.
12.	Detect an object in an image/video using template matching/Bayes classifier.
	TOTAL: 30 PERIODS
	TOTAL(T+P): 75 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the limitations of the computational methods on digital images.
CO2:	Explain the algorithms available for performing analysis on video data and address the challenges.
CO3:	Illustrate the need for compression and the basic compression algorithms.
CO4:	Develop the desired signal parameters and information from the signal corrupted by noisy channel.
CO5:	Construct the spatial and frequency domain image transforms on enhancement and restoration of images.

REFERENCES:

1.	Digital Image Processing - Rafael C. Gonzalez, Richard E. Woods, 4th Edition, Pearson, 2017.
2.	John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2014.
3.	Digital Image Processing and Analysis-Human and Computer Vision Application with using CVIP Tools - Scotte Umbaugh, 2nd Ed, CRC Press, 2011.
4.	John C. Russ, F. Brent Neal-The Image Processing Handbook, Seventh Edition, The Kindle edition (2016), CRC Press,Taylor & Francis Group.
5.	John G. Proakis, Masoud Salehi, “Communication Systems Engineering”, Prentice Hall, 2018.
6.	Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2022.
7.	Yao Wang, Jorn Ostermann and Ya-Qin Zhang, “Video Processing and Communications”, Prentice Hall, 2001.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	1	1	1
CO2	2	2	2	1	1	1
CO3	2	2	2	1	1	1
CO4	2	2	2	1	1	1
CO5	2	2	2	1	1	1
CO	2	2	2	1	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I:Digital Image Fundamentals	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Image Enhancement and Segmentation Techniques	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Video Processing and Motion Estimation	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Introduction: Video Analytics	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Motion Understanding	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	
Weightage	20%	80%	14%	54%	32%	

Weightage for Cos

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22312	RADAR SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the Radar Signal acquisition and sampling in multiple domains
- To provide clear instruction in radar DSP basics
- To equip the skills needed in both design and analysis of common radar algorithms
- To understand the basics of synthetic aperture imaging and adaptive array processing
- To illustrate how theoretical results are derived and applied in practice

UNIT I	INTRODUCTION TO RADAR SYSTEMS	9

History and application of radar, basic radar function, elements of pulsed radar,review of signal processing concepts and operations, the Low-Angle Tracking Radar Problem, A preview of basic radar signal processing, radar system components, advanced radar signal processing

UNIT II	SIGNAL MODELS	9

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III	SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS	9

Domains and criteria for sampling radar signals, Sampling in the fast time dimension,Sampling in slow time: selecting the pulse repetition interval,sampling the dopplerspectrum,Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

UNIT IV	RADAR WAVEFORMS	9

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

UNIT V	DOPPLER PROCESSING	9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1.	Matched filtering operation
2.	Modeling the Propagation of Radar Signals
3.	Modeling of radar targets
4.	Density-based algorithm for clustering data.
5.	MTI radar design, target detection in noise
6.	Estimation of bearing angle in noise, clutter modelling
7.	Frequency modulated radar signal generation
8.	Doppler shift Signal strength
9.	SNR loss measurement in pulse compression
10.	Detection performance of a radar system

TOTAL:45+30=75 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the various techniques of radar signal acquisition and processing.
CO2:	Outline the different signal models related to radar signal.
CO3:	Summarize sampling and quantization of pulsed radar signals.
CO4:	Identify various radar waveforms and COSTAS frequency codes.

CO5:	Make use of the Doppler spectrum and processing in practice.

REFERENCES:	
1.	Introduction To Radar Systems 3/E, Skolnik, McGraw Hill. 2017
2.	Michael O Kolawole, "Radar systems, Peak Detection and Tracking", Elseveir. 2003.
3.	Radar Principles, Peyton Z. Peebles, Wiley India 2009
4.	Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M, "Fundamentals of Queueing Theory", 4th Edition, Wiley, 2013.
5.	And Marvin N. Cohen, Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI, 2nd edition, 2006.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	1	2	-	2
CO2	2	1	1	2	-	2
CO3	2	1	1	2	-	2
CO4	2	1	1	2	-	2
CO5	2	1	1	2	-	2
CO	2	1	1	2	-	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction to Radar Systems	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Signal Models	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Sampling and Quantization of Pulsed Radar Signals	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Radar Waveforms	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Doppler Processing	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-

Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22313	**TELECOMMUNICATION SYSTEM MODELING AND SIMULATION**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES:

- To enable the student to understand the various aspects of simulation methodology and performance
- To appreciate the significance of selecting sampling frequency and modeling different types of signals and processing them
- To expose the student to the different simulation techniques, their pros and cons and enable him to understand and interpret results using case studies

UNIT I	**SIMULATION METHODOLOGY**	**9**

Introduction, Aspects of methodology, Performance Estimation, Simulation sampling frequency, Low pass equivalent simulation models for bandpass signals, Multicarrier signals, Non-linear and time-varying systems, Post processing – Basic graphical techniques and estimations

UNIT II	**RANDOM SIGNAL GENERATION & PROCESSING**	**9**

Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Correlated and Uncorrelated Gaussian random number generation, PN sequence generation, Random signal processing, Testing of random number generators.

UNIT III	**MONTE CARLO SIMULATION**	**9**

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi - analytic techniques, Case study: Performance estimation of a wireless system

UNIT IV	**ADVANCED MODELS & SIMULATION TECHNIQUES**	**9**

Modeling and simulation of non-linearities : Types, Memoryless non-linearities, Non-linearities with memory, Modeling and simulation of Time varying systems : Random process models, Tapped delay line model, Modeling and simulation of waveform channels, Discrete memoryless channel models, Markov model for discrete channels with memory.

UNIT V	**EFFICIENT SIMULATION TECHNIQUES**	**9**

Tail extrapolation, pdf estimators, Importance Sampling methods, Performance evaluation techniques, Case study: Simulation of a Cellular Radio System.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1.	Observe the BER performance of DS-CDMA using mixed codes in multipath channels using a RAKE receiver for a single user case using SDR.
2.	OFDM Channel Estimation with Zero Force Method (Least Squares) and Modified Least Squares (MLS) using SDR.
3.	Generation of uniform / Gaussian random numbers and verification of their probability distribution, autocorrelation and spectrum
4.	Generation of uncorrelated and correlated random processes and verification of cross-

	correlations
5.	Generation of PN sequence and verification of properties and spectrum.
6.	Application of Monte Carlo simulation for estimation of BER of a wireless communication link
7.	Study the impact of non-linearity of amplifier on transmitter symbol constellation with the help of Saleh model
8.	Studying the effect of time invariant (slow fading) frequency selecting channel with the help of symbol constellation
9.	Studying the effect of time variant flat fading (memoryless) channel with the help of symbol constellation
	TOTAL: 75 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain simulation methodologies in system modeling.
CO2:	Outline random signal generation and processing techniques.
CO3:	Illustrate the fundamental concepts of Monte Carlo integration.
CO4:	Build knowledge of the different simulation techniques for designing a communication system or channel
CO5:	Make use of efficient simulation techniques in telecommunication system modeling.

REFERENCES:

1.	Averill.M.Law, Simulation Modeling and Analysis, McGraw Hill Inc., 5th Edition 2015.
2.	M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, Simulation of Communication Systems: Modeling, Methodology and Techniques, Plenum Press, New York, 2001.
3.	William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore) Pvt. Ltd, 2004.
4.	Geoffrey Gorden, System Simulation, Prentice Hall of India, 2nd Edition, 1992.
5.	Jerry Banks and John S. Carson, Discrete Event System Simulation, Prentice Hall of India, 1984.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	1	-	1	2
CO2	2	1	1	-	1	2
CO3	2	1	1	-	1	2
CO4	2	1	1	-	1	2
CO5	2	1	1	-	1	2
CO	2	1	1	-	1	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)

Unit-I: Simulation Methodology	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Random Signal Generation & Processing	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Monte Carlo Simulation	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Advanced Models & Simulation Techniques	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Efficient Simulation Techniques	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22314	**SIGNAL DETECTION AND ESTIMATION**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES:

- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I	**REVIEW OF PROBABILITY AND STOCHASTIC PROCESS**	**9**

Conditional Probability, Bayes' Theorem , Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete Time Stochastic Processes, Spatial Stochastic Processes, Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

UNIT II	**SINGLE AND MULTIPLE SAMPLE DETECTION**	**9**

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson

Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise, Performance of Binary Receivers in AWGN.

UNIT III	**FUNDAMENTALS OF ESTIMATION THEORY**	**9**

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters.

UNIT IV	**WIENER AND KALMAN FILTERS**	**9**

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, Least Squares, Kalman filters: Gauss -Markov state variable models; innovation and Kalman recursion, steady-state behaviour of Kalman filters.

UNIT V	**APPLICATIONS**	**9**

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

45 PERIODS

PRACTICALS: 30 PERIODS

List of Experiments:

Software Requirement: Matlab / Python / Equivalent

1. Power Spectrum Estimation of a Random Signal
2. Maximum Likelihood Estimation
3. Design of optimum receiver in AWGN channel
4. Wiener Filter Design
5. Adaptive Filter Design using LMS algorithm
6. Minimum Variance Estimation

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1:	Acquire basics of statistical decision theory used for signal detection and estimation.
CO2:	Interpret the detection of deterministic and random signals using statistical models.
CO3:	Explain signal estimation in discrete-time domain using filters.
CO4:	Outline Wiener and Kalman filters to solve linear estimation problems.
CO5:	Identify the performance of signal parameters using optimal estimators.

REFERENCES:

1.	Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2004.
2.	Ludeman, Lonnie C. Random processes: filtering, estimation, and detection. John Wiley & Sons, Inc., 2003
3.	Sergio Verdu " Multi User Detection" Cambridge University Press, 1998
4.	Steven M. Kay, "Fundamentals of Statistical Processing, Volume I: Estimation Theory", Prentice Hall Signal Processing Series, Prentice Hall, PTR, NewJersy, 1993.
5.	Thomas Schonhoff, "Detection and Estimation Theory", Prentice Hall, NewJersy, 2007

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	-	2
CO2	2	-	2	2	-	2
CO3	2	-	2	2	-	2
CO4	2	-	2	2	-	2
CO5	2	-	2	2	-	2
CO	2	-	2	2	-	2

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I:Review of Probability And Stochastic Process	2	1either or	2(2)-CO1	1either or (16)-CO1	-	
Unit-II: Single and Multiple Sample Detection	2	1either or	2(2)-CO2	1either or (16)-CO2	-	
Unit-III: Fundamentals of Estimation Theory	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	
Unit-IV: Wiener and Kalman Filters	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Applications	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22315	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basics of embedded system and ARM architecture
- To understand the RTOS concepts like scheduling and memory management related to the embedded system
- To learn about the programming aspects of RTOS
- To learn the different protocols of embedded wireless application
- To understand concepts involved in the design of hardware and software components for an embedded system

UNIT I	INTRODUCTION	9

Real Time System – Embedded Systems – Architecture of Embedded System – Simple Programming for Embedded System – Process of Embedded System Development – Pervasive Computing – Information Access Devices – Smart Cards – Microcontrollers – ARM Processor - Real Time Microcontrollers.

UNIT II	EMBEDDED/REAL TIME OPERATING SYSTEM	9

Operating System Concepts: Processes, Threads, Interrupts, Events - Real Time Scheduling Algorithms - Memory Management – Overview of Operating Systems for Embedded, Real Time Handheld Devices – Target Image Creation – Programming in Linux, Rtlinux, Vxworks, Microcontroller.

UNIT III	CONNECTIVITY	9

Wireless Connectivity - Bluetooth – Other Short-Range Protocols – Wireless Application Environment – Service Discovery – Middleware. -WIFI

UNIT IV	REAL TIME UML	9

Requirements Analysis – Object Identification Strategies – Object Behaviour – Real Time Design Patterns. Advantages of Modelling

UNIT V	SOFTWARE DEVELOPMENT AND APPLICATION	9

Concurrency – Exceptions – Tools – Debugging Techniques – Optimization –Interfacing Digital Camera with USB Port, Internet enabled Systems.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

LIST OF EXPERIMENTS

1. Read Input from Switch and Automatic Control/Flash LED for ARM Processor
2. Laboratory Exercises on Task Scheduling
3. Simple Program in Linux, Rtlinux and Vxworks
4. Interfacing stepper motor and temperature sensor.
5. Interfacing ADC and DAC
6. Develop a Real Time Security Monitoring System

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1:	Describe the basic concepts of real-time embedded processors.
CO2:	Explain the real-time operating system for the embedded system.

CO3:	Demonstrate wireless communication protocols.
CO4:	Develop different object modelling schemes for embedded systems.
CO5:	Model the aspects of embedded software development in real-time systems.
REFERENCES:	
1.	R.J.A. Buhr, D.L. Bailey, "An Introduction to Real-Time Systems", Prentice-Hall International, 1999.
2.	David E-Simon, "An Embedded Software Primer", Pearson Education, 2007.
3.	C.M. Krishna, Kang G. Shin, "Real Time Systems", Mc-Graw Hill, 2010.
4.	B. P. Douglass, "Real Time UML - Advances in the UML for Real-Time Systems, 3rd Edition Addison-Wesley, 2004.
5.	K.V.K. Prasad, "Embedded/Real Time Systems: Concepts, Design and Programming", Dream Tech Press, Black Book, 2005.
6.	R. Barnett, L.O. Cull, S. Cox, "Embedded C Programming and the Microchip PIC", Thomason Learning, 2004.
7.	Wayne Wolf, "Computers as Components - Principles of Embedded Computer System Design", Mergen Kaufmann Publisher, 2006.
8.	Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata Mc-Graw Hill, 2004.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	1	2
CO2	2	2	2	2	1	2
CO3	2	2	2	2	1	2
CO4	2	2	2	2	1	2
CO5	2	2	2	2	1	2
CO	2	2	2	2	1	2

Table of Specification for End Semester Question Paper

Unit No. and Title	**Total 2 Marks Qus.**	**Total 16 Marks Qus.**	**Cognitive Level Programme Outcomes**					
	Course Outcomes		**Remember (Kn)**	**Understand (Un)**	**Apply (Ap)**	**Analyse(An) Evaluate(Ev)**		
			PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Unit-I: Introduction	**CO1**	1either or	2(2)-CO1	1either or (16)-CO1	-	-		
Unit-II: Embedded/Real Time Operating System	**CO2**	1either or	1(2)-CO2	1(2)-CO2	-	-		
	CO3							
	CO4							
	CO5							
	CO							
Unit-III: Connectivity	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-		
Unit-IV: Real Time UML	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-	-		

					CO4	
Unit-V: Software Development And Application	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	6(2)	4(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	12	56	32	-
Weightage	20%	80%	12%	56%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER III, PROFESSIONAL ELECTIVE – V

CU22321	**SOFTWARE DEFINED RADIOS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn various design principles of software defined radio.
- To understand challenges of receiver design.
- To design smart antennas for SDR.

UNIT I	**INTRODUCTION TO SOFTWARE RADIO CONCEPTS**	**9**

SDR concepts & history, Need for SDR, Benefits of SDR, SDR Forum, Ideal SDR architecture, Worldwide frequency band plans, Aim and requirements of the SCA. Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems.

UNIT II	**RADIO FREQUENCY IMPLEMENTATION ISSUES**	**9**

Purpose of RF front – end, Dynamic range, RF receiver front – end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components to overall performance, Transmitter architectures and their issues, Noise and distortion in the RF chain, ADC & DAC distortion, Pre-distortion, Flexible RF systems using micro-electromechanical systems.

UNIT III	**MULTIRATE SIGNAL PROCESSING IN SDR**	**9**

Sample rate conversion principles, Polyphase filters, Digital filter banks, Timing recovery in digital receivers using multirate digital filters.

UNIT IV	**SMART ANTENNAS**	**9**

Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Hardware implementation of smart antenna, Convergence between military and commercial systems, The Future For Software Defined Radio.

UNIT V	OBJECT ORIENTED REPRESENTATION OF RADIOS AND NETWORK	9
Networks, Object –oriented programming, Object brokers, Mobile application environments, **Case Studies in Software Radio Design:** SPEAKeasy, JTRS, Wireless Information transfer system, SDR-3000 digital transceiver subsystem, Spectrum Ware, Brief introduction to Cognitive Networking.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Demonstrate advanced knowledge in the evolving paradigm of Software defined radio and technologies for its implementation.
CO2:	Explain the complex problems critically in the domains of Radio frequency implementation.
CO3:	Interpret multirate signal processing in SDR
CO4:	Explain Smart antenna techniques for better spectrum exploitation.
CO5:	Identify the appropriate techniques for the development of scientific and technological knowledge in designing software defined radios.

REFERENCES:

1.	1. Jeffrey Hugh Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice, Hall Professional, 2002.
2.	Paul Burns, "Software Defined Radio for 3G," Artech House, 2002.
3.	P. Kenington, "RF and Baseband Techniques for Software Defined Radio," Artech House,2005
4.	Bard, Kovarik, Software Defined Radio, the Software Communications Architecture, Wiley, 2007.
5.	Travis F. Collins, Robin Getz, Di Pu, and Alexander M. Wyglinski, "Software-Defined Radio for Engineers," Artech House, 2018

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	1	-	-
CO2	2	2	2	1	-	-
CO3	2	2	2	1	-	-
CO4	2	2	2	1	-	-
CO5	2	2	2	1	-	-
CO	2	2	2	1	-	-

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To Software Radio Concepts	2	1either or	1(1)-CO1	1(1)-CO1 1either or (16)-CO1	-	-
Unit-II: Radio Frequency Implementation Issues	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Multirate Signal Processing In SDR	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Smart Antennas	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: Object Oriented Representation of Radios And Network	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	6(2)	4(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	12	72	16	-
Weightage	20%	80%	12%	72%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22322	**RF SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Be familiar with RF transceiver system design for wireless communications.
- Be exposed to design methods of receivers and transmitters used in communication systems.
- Design RF circuits and systems using an advanced design tool.
- Exemplify different synchronization methods circuits and describe their block schematic and design criteria.
- Measure RF circuits and systems with a spectrum analyzer.

UNIT I	BASICS OF RADIO FREQUENCY SYSTEM DESIGN	9
Definitions and models of Linear systems and Non-linear system. Specification parameters: Gain, noise figure, SNR, Characteristic impedance, S-parameters, Impedance matching and Decibels. Elements of digital base band signaling: complex envelope of band pass signals, Average value, RMS value, Crest factor, Sampling, jitter, modulation techniques, filters, pulse shaping, EVM, BER, sensitivity, selectivity, dynamic range and, adjacent and alternate channel power leakages.		
UNIT II	**RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS**	**9**
Super heterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture, System Design Considerations for an Analog Frontend Receiver in Cognitive Radio Applications, Interference, Near, In-band & wide-band considerations.		
UNIT III	**AMPLIFIER MODELING AND ANALYSIS**	**9**
Noise: Noise equivalent model for Radio frequency device, amplifier noise model, cascade Performance, minimum detectable signal, performance of noisy systems in cascade. Non-Linearity: Amplifier power transfer curve, gain compression, AM-AM, AM-PM, polynomial approximations, Saleh model, Wiener model and Hammerstein model, intermodulation, Single and two tone analyses, second and third order distortions and measurements, SOI and TOI points, cascade performance of nonlinear systems.		
UNIT IV	**MIXER AND OSCILLATOR MODELING AND ANALYSIS**	**9**
Mixers: Frequency translation mechanisms, frequency inversion, image frequencies, spurious calculations, principles of mixer realizations. Oscillators: phase noise and its effects, effects of oscillator spurious components, frequency accuracy, oscillator realizations: Frequency synthesizers, NCO.		
UNIT V	**APPLICATIONS OF SYSTEMS DESIGN**	**9**
Multimode and multiband Super heterodyne transceiver: selection of frequency plan, receiver system and transmitter system design – Direct conversion transceiver: receiver system and transmitter system design.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basic model and elements of radio frequency system design.
CO2:	Outline RF transceiver system design for wireless communications.
CO3:	Summarize the impact of noise in amplification modules and the resultant effect during cascade connections.
CO4:	Identify spurs and generation principles during signal generation and frequency translations.
CO5:	Choose the transceivers for various RF applications.

REFERENCES:

1.	Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004.
2.	Ian Marsland, Calvin Plett and John Rogers," Radio Frequency System Architecture and Design" Artech House Publishers, 2013.
3.	Augusto Marques and Sandeep Perdoor," BLE Radio Architectures and Design for the IoT Market", River Publishers, 1st Edition, 2017.

4.	Wim Rouwet," Open Radio Access Network (O-RAN) Systems Architecture and Design", Academic Press, 2022.
5.	Tertulien Ndjountche,"CMOS Analog Integrated Circuits -High-Speed and Power-Efficient Design", Second Edition, CRC Press, 2020.
6.	Qizheng Gu,"RF System Design of Transceivers for Wireless Communications", Springer 2006.
7.	Alan Davis W,"Radio Frequency Circuit Design" , 2nd Edition, Wiley-IEEE Press, 2010.
8.	Kevin McClaning, "Wireless Receiver Design for Digital Communications,"2/3, Yes Dee Publications, 2012.
9.	Mayavanshi Manisha V and Prajapati Pravin R," Semiconductor Optical Amplifier - Modeling, Analysis and Simulation", LAP Lambert Academic Publishing,2015.
10.	Jingchang Nan and Mingming Gao," Power Amplifier Behavioral Model and Nonlinear Analysis Basis", 1st Edition, CRC Press 2021.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	2	1
CO2	2	-	2	2	2	1
CO3	2	-	2	2	2	1
CO4	2	-	2	2	2	1
CO5	2	-	2	2	2	1
CO	2	-	2	2	2	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Basics of radio frequency system design	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Radio architectures and design considerations	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Amplifier modeling and analysis	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-

Unit-IV: Mixer and oscillator modeling and analysis	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Applications of systems design	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22323	**ADVANCED WIRELESS NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- Study about wireless IP architecture, Packet Data Protocol and LTE network architecture
- Study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- Study about mobility management, cellular network, and micro cellular networks

UNIT I	**INTRODUCTION**	**9**

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTE-A - Wireless Standards. Network Model-Network Connectivity- LTE-Advanced Performance and Future Developments.

UNIT II	**WIRELESS IP NETWORK ARCHITECTURES**	**9**

Radio Interface Techniques in 3GPP Systems-3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context -Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain –LTE network Architecture - Roaming Architecture- Protocol Architecture.

UNIT III	**ADAPTIVE LINK AND NETWORK LAYER**	**9**

Link Layer Capacity of Adaptive Air Interfaces-Adaptive Transmission in Ad Hoc Networks-Adaptive Hybrid ARQ Schemes for Wireless Links-Stochastic Learning Link Layer Protocol-Infrared Link Access Protocol-Graphs and Routing Protocols-Graph Theory-Routing with Topology Aggregation-Network and Aggregation Models.

UNIT IV	**MOBILITY MANAGEMENT**	**9**

Mobility management- Location registration and call delivery -Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution- Mobility Prediction in Pico- and Micro-Cellular

Networks.		
UNIT V	**QUALITY OF SERVICE**	**9**
QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearers and QoS in LTE networks.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Describe the latest 4G networks and LTE
CO2:	Illustrate the wireless IP architecture and LTE network architecture.
CO3:	Explain the adaptive link layer and network layer graphs and protocol.
CO4:	Summarize the mobility management and cellular network.
CO5:	Build the wireless sensor network architecture and its concept.

REFERENCES:

1.	Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, "Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach", John Wiley & Sons, 2014.
2.	Crosspoint Boulevard, "Wireless and Mobile All-IP Networks", Wiley Publication, 2005.
3.	Jyh-Cheng Chen and Tao Zhang, "IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols", John Wiley & Sons, Inc. Publication,2006.
4.	Savo Glisic,"Advanced Wireless Networks-4G Technologies", John Wiley & Sons, Ltd,2006.
5.	Minoru Etoh, "Next Generation Mobile Systems3G and Beyond," Wiley Publications,2005.
6.	Savo Glisic," Advanced Wireless Networks-Technology and Business Models", Third Edition, John Wiley & Sons, Ltd, 2016
7.	Stefania Sesia, IssamToufik and Matthew Baker, "LTE – The UMTS Long Term Evolution From Theory to Practice", John Wiley & Sons, Inc. Publication, Second Edition, 2011

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	2	1
CO2	1	-	2	2	2	1
CO3	1	-	2	2	2	1
CO4	1	-	2	2	2	1
CO5	1	-	2	2	2	1
CO	1	-	2	2	2	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-

Unit-II: Wireless IP Network Architectures	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Adaptive Link And Network Layer	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Mobility Management	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: Quality Of Service	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5	-	-
Total Qns.	10	5either or	7(2)	3(2) 4 either or (16)	1either or (16)-CO5	-
Total Marks	20	80	14	70	16	-
Weightage	20%	80%	14%	70%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

CU22324	**OPTICAL COMMUNICATION AND NETWORKING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Understand the basic principles of operation of optical system components, the different network architectures and issues associated with network design.
- Understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.

UNIT I	**OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN**	**9**

Optical System Components – MZIM, Multiplexers; filters; switches; wavelength converters; optical amplifiers – EDFA, Raman Amplifiers and hybrid; Transmission system Engineering – System Model, Aimer penalty – transmitter, receiver, cross talk, dispersion compensation, wavelength stabilization, FWM.

UNIT II	**COHERENT SYSTEMS**	**9**

Basic principles of Coherent detections – Practical constraints – Injection laser line width state of polarization, local oscillator power, fiber limitations; Modulation formats – ASK, FSK, PSK, DPSK and polarization shift keying (POL SK); Demodulation schemes – Homodyne, Heterodyne – Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

UNIT III	**OPTICAL NETWORK ARCHITECTURES**	**9**

Introduction to Optical Networks; First Generation optical networks –SONET / SDH Network, Second Generation (WDM) Optical Networks, Need for Multilayered Architecture-, Layers and Sublayers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays.		
UNIT IV	**NETWORK CONNECTIONS**	**9**
Connection Management and Control; Static Networks, Wavelength Routed Networks; Linear Light wave networks; Logically Routed Networks; Routing and Wavelength Assignment , Traffic Grooming in Optical Networks.		
UNIT V	**OPTICAL NETWORK SURVIVABILITY**	**9**
Protection and Restoration Objectives, Fault Protection and Restoration Techniques in the Logical 27 Layer – Point-to-Point Systems, SONET Self-Healing Rings, Interconnection Techniques, Architectures with Arbitrary Mesh Topologies, Optical-Layer Protection: Point-to-Point and Ring Architectures, Mesh Architectures.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the differences and challenges involved in the design of optical systems and networks.
CO2:	Interpret and formulate different Modulation Demodulation schemes.
CO3:	Familiarize with the architectures and the protocol stack used in optical networks for identify a suitable backbone infrastructure for communication needs.
CO4:	Demonstrate how connections are managed in the network and the pros and cons of the different approaches.
CO5:	Identify the need for network survivability and the methodologies used.

REFERENCES:

1.	Max Ming-Kang Liu, “Principles and Applications of Optical Communication”, Tata McGraw Hill Education Pvt., Ltd., New Delhi. 2010.
2.	Thomas E. Stern, Georgios Ellinas, Krishna Bala, “Multiwavelength Optical Networks – Architecture, Design and control “, Cambridge University Press, 2nd Edition, 2009.
3.	Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, Harcourt Asia Pte Ltd., Second Edition 2006.
4.	Gred Keiser,"Optical Fiber Communication, McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.
5.	John M.Senior, ―Optical fiber communication, Pearson Education, second edition, 2007.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	1	1
CO2	1	-	2	2	1	1
CO3	1	-	2	2	1	1
CO4	1	-	2	2	1	1
CO5	1	-	2	2	1	1
CO	1	-	2	2	1	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Optical System Components And Network Design	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Coherent Systems	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Optical Network Architectures	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Network Connections	2	1either or	1(2)-CO4	1(2)-CO4 1either or (16)-CO4	-	-
Unit-V: Optical Network Survivability	2	1either or	1(2)-CO5	1(2)-CO5 1either or (16)-CO5	-	-
Total Qns. Title	10	5either or	7(2)	3(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	14	70	16	-
Weightage	20%	80%	14%	70%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AE22322	DIGITAL HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT I	SIGNAL PROPAGATION ON TRANSMISSION LINES	9

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance, wave propagation, reflection, and bounce diagrams Reactive terminations – L, C, static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching, input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II	MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK	9

Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits, S-parameters, Lossy and Lossless models.

UNIT III	NON-IDEAL EFFECTS	9

Non-ideal signal return paths – gaps, BGA fields, via transitions, Parasitic inductance and capacitance, Transmission line losses – Rs, tanδ, routing parasitic, Common-mode current, differential-mode current, Connectors.

UNIT IV	POWER CONSIDERATIONS AND SYSTEM DESIGN	9

SSN/SSO, DC power bus design, layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, jitter , inter-symbol interference Bit-error rate, Timing analysis.

UNIT V	CLOCK DISTRIBUTION AND CLOCK OSCILLATORS	9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, cancelling parasitic capacitance, Clock jitter, Applications of Clock Oscillator.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1:	Define the sources affecting the speed of digital circuits.
CO2:	Identify methods to improve the signal transmission characteristics.
CO3:	Explain the non-ideal effects of signal.
CO4:	Compute the power consideration for the system.
CO5:	Estimate the clock distribution.

REFERENCES:

1.	H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 1993.
2.	Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall Modern Semiconductor Design, 2012.
3.	S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.
4.	Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

5.	Stephen C. Thierauf, High-Speed Circuit Board Signal Integrity,Artech house Inc.,2004.
TOOLS REQUIRED	
1.	SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html
2.	HSPICE from synopsis, www.synopsys.com/products/ mixedsignal/hspice/hspice.html
3.	SPECCTRAQUEST from Cadence, http://www.specctraquest.com

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	1	2	2	1
CO2	2	1	1	2	2	1
CO3	2	1	1	2	2	1
CO4	2	1	1	2	2	1
CO5	2	1	1	2	2	1
CO	2	1	1	2	2	1

Table of Specification for End Semester Question Paper

Unit No. and Title	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Signal Propagation on Transmission Lines	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Multi-Conductor Transmission Lines And Cross-Talk	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Non-Ideal Effects	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: **P**ower Considerations And System Design	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Clock Distribution And Clock Oscillators	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-

Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AUDIT COURSES

AC22101	**ENGLISH FOR RESEARCH PAPER WRITING**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I	**INTRODUCTION TO RESEARCH PAPER WRITING**	**6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II	**PRESENTATION SKILLS**	**6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III	**TITLE WRITING SKILLS**	**6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV	**RESULT WRITING SKILLS**	**6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V	**VERIFICATION SKILLS**	**6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Understand that how to improve your writing skills and level of readability
CO2:	Learn about what to write in each section
CO3:	Understand the skills needed when writing a Title

CO4:	Understand the skills needed when writing the Conclusion
CO5:	Ensure the good quality of paper at very first-time submission

REFERENCES:

1	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2	Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	1	-	-
CO2	-	2	-	1	-	-
CO3	-	2	-	1	-	-
CO4	-	2	-	1	-	-
CO5	-	2	-	1	-	-
CO	-	2	-	1	-	-

AC22102	**CONSTITUTION OF INDIA**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OBJECTIVES:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

UNIT I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION**	**6**

History, Drafting Committee, (Composition & Working)

UNIT II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**6**

Preamble, Salient Features.

UNIT III	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**	**6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV	**ORGANS OF GOVERNANCE**	**6**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive,

President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
UNIT V	**LOCAL ADMINISTRATION**	**6**
District's Admini of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.		
UNIT VI	**ELECTION COMMISSION**	**6**
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.		
TOTAL: 30 PERIODS		

COURSE OUTCOMES:	
Upon completion of the course, the students will be able to	
CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2:	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4:	Discuss the passage of the Hindu Code Bill of 1956.
CO5:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

REFERENCES:

1	The Constitution of India,1950(Bare Act),Government Publication.
2	Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,First Edition, 2015.
3	M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	1	-	-	-
CO2	-	2	1	-	-	-
CO3	-	2	1	-	-	-
CO4	-	2	1	-	-	-
CO5	-	2	1	-	-	-
CO	-	2	1	-	-	-

AC22201	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I	INTRODUCTION	6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III	DISASTER PRONE AREAS IN INDIA	6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics.

UNIT IV	DISASTER PREPAREDNESS AND MANAGEMENT	6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V	RISK ASSESSMENT	6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Summarize basics of disaster
CO2:	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3:	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4:	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5:	Develop the strengths and weaknesses of disaster management approaches.

REFERENCES:

1	Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2	NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company, 2007.
3	Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi, 2001.
4	Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	1	2
CO2	1	-	-	-	1	2
CO3	1	-	-	-	1	2
CO4	1	-	-	-	1	2
CO5	1	-	-	-	1	2
CO	1	-	-	-	1	2

AC22202	**நற்றமிழ் இலக்கியம்**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**
UNIT I	**சங்க இலக்கியம்**				**6**
1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள் 2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம் 3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி 4. புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார்					
UNIT II	**அறநெறித் தமிழ்**				**6**
1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ் 2. பிற அறநூல்கள் - இலக்கிய மருந்து – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)					
UNIT III	**இரட்டைக் காப்பியங்கள்**				**6**
1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை 2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை					
UNIT IV	**அருள்நெறித் தமிழ்**				**6**
1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப்					

போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்

UNIT V	**நவீன தமிழ் இலக்கியம்**	6

1.உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,

2.நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4.பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5.அறிவியல் தமிழ்,
6.இணையத்தில் தமிழ்,
7.சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

REFERENCES:

1	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
2	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
3	தர்மபுர ஆதீன வெளியீடு
4	வாழ்வியல் களஞ்சியம்
5	தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்