SRM VALLIAMMAI ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION)

SRM Nagar, Kattankulathur - 603 203.

Approved by AICTE, Affiliated to Anna University,
Accredited by NBA 'A' Grade Accreditation by NAAC,
ISO 9001: 2015 Certified

CURRICULUM AND SYLLABUS

M.E - COMMUNICATION SYSTEMS

REGULATION 2023

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

M.E. COMMUNICATION SYSTEMS

REGULATIONS – 2023

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO1: To educate graduates who will develop as ethical, productive and contributing members of society.

PEO2: To provide a solid foundation for professional development in communication systems.

PEO3: To develop the ability to use their communication engineering foundation for success in technical careers in industry, academia, government or other organizations.

PEO4: To provide students with an academic environment that make them aware of excellence and lifelong learning in emerging technologies.

II. PROGRAMME OUTCOMES (POs):

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings.

10	Communication	Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1: To inculcate the ability in graduates to design and analyze the subsystems such as RF, Signal Processing, Modern communication systems and networks.

PSO2: To enhance problem solving skills in communication systems design using latest hardware and software tools.

PSO3: To apply communication engineering principles and practices for developing products for scientific applications.

PSO4: To develop and apply innovative solutions to real world problems using appropriate research techniques.

IV. PEO / PO Mapping:

Programme Educational Objectives (PEOs)	Program Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	-	-	-	-	-	3	-	3	3	1	-	-	2	2	3	3
2	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	3
3	2	2	2	2	-	1	-	-	-	2	2	3	3	3	3	3
4	-	-	-	-	-	3	3	-	-	-	-	3	-	-	3	2

Contribution: **1:Reasonable** **2:Significant** **3:Strong**

MAPPING – PG – COMMUNICATION SYSTEMS

Year	Sem	Subject Name/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
I	I	Advanced Mathematics for Communication	3	2	2	1	-	-	-	-	-
		Statistical Signal Processing	2.5	1.8	2.8	1.7	1.3	-	2.0	1.0	-
		Modern Digital Communication Systems	3.0	-	2.5	1.8	3.0	2.0	3.0	3.0	2.0
		Advanced Wireless Communication	1.0	-	2.2	2.3	1.0	1.0	1.7	1.7	1.4
		Advanced Radiating Systems	3.0	2.7	2.8	2.4	-	2.0	2.2	2.0	2.0
		Machine Learning Techniques	3.0	3.0	3.0	3.0	2.0	3.0	2.2	2.2	-
		Digital Communication Systems Laboratory	2.0	-	2.8	2.7	3.0	2.0	3.0	3.0	3.0
		Advanced Digital Signal Processing Laboratory	2.5	-	2.8	3.0	1.3	-	2.0	1.0	-
I	II	CMOS VLSI Design	1.0	1.0	3.0	3.0	1.3	1.3	1.0	1.0	2.3
		RF AND MIC	3.0	2.8	2.8	2.5	-	-	2.0	1.5	2.0
		Advanced Wireless Networks	2.8	2.0	2.0	2.2	1.3	2.0	2.8	1.8	2.2
		Optical Communication and Networking	1.8	1.5	2.0	2.0	1.0	-	2.8	1.8	1.8
		Professional Elective I									
		Professional Elective II									
		Wireless Communication Laboratory	1.0	2.0	1.8	2.0	1.5	1.0	1.8	1.3	2.0
		Mini Project	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0
II	III	Research Methodology and IPR	1.3	1.5	-	1.3	-	-	-	-	-
		Professional Elective III									
		Professional Elective IV									
		Term Paper Writing and seminar	2.8	2.0	2.2	1.3	-	-	1.5	1.3	1.2
		Project Work Phase - I	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0
		Internship	2.8	3.0	3.0	2.7	2.7	2.3	2.7	2.7	2.7
II	IV	Project Work Phase - II	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0

SRM VALLIAMMAI ENGINEEERING COLLEGE, CHENNAI

(AN AUTONOMOUS INSTITUTION)

REGULATION-2023

CHOICE BASED CREDIT SYSTEM

M.E –COMMUNICATION SYSTEMS

CURRICULUM FOR SEMESTER I TO IV

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA3124	Advanced Mathematics for Communication Engineering	BSC	4	4	0	0	4
2.	CU3161	Statistical Signal Processing	PCC	3	3	0	0	3
3.	CU3162	Modern Digital Communication Systems	PCC	3	3	0	0	3
4.	CU3163	Advanced Wireless Communication	PCC	3	3	0	0	3
5.	CU3164	Advanced Radiating Systems	PCC	3	3	0	0	3
6.	DS3162	Machine Learning Techniques	PCC	3	3	0	0	3
PRACTICAL								
7.	CU3165	Digital Communication Systems Laboratory	PCC	3	0	0	3	1.5
8.	CU3166	Advanced Digital Signal Processing Laboratory	PCC	3	0	0	3	1.5
			TOTAL	**25**	**19**	**0**	**6**	**22**

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CU3261	CMOS VLSI Design	PCC	3	3	0	0	3
2.	CU3262	RF AND MIC	PCC	3	3	0	0	3
3.	CU3263	Advanced Wireless Networks	PCC	3	3	0	0	3
4.	CU3264	Optical Communication and Networking	PCC	3	3	0	0	3
5.	PCU1XX	Professional Elective I	PEC	3	3	0	0	3
6.	PCU1XX	Professional Elective II	PEC	3	3	0	0	3
PRACTICAL								
7.	CU3265	Wireless Communication Laboratory	PCC	4	0	0	4	2
8.	CU3246	Mini Project	EEC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BA3371	Research Methodology and IPR	RMC	3	3	0	0	3
2.	PCU1XX	Professional Elective III	PEC	3	3	0	0	3
3.	PCU1XX	Professional Elective IV	PEC	3	3	0	0	3
PRACTICAL								
4.	CU3341	Term Paper Writing and seminar	EEC	2	0	0	2	1
5.	CU3342	Project Work Phase - I	EEC	12	0	0	12	6
6.	CU3343	Internship@	EEC	0	0	0	0	2
			TOTAL	**23**	**9**	**0**	**14**	**18**

@ - Internship for Four weeks

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	CU3441	Project Work Phase - II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

Total Credits: 74

PROFESSIONAL ELECTIVES

SEMESTER II, ELECTIVE - I

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PCU101	Electromagnetic Interference and Compatibility	PEC	3	3	0	0	3
2.	PCU102	Advanced Satellite Communication and Navigation Systems	PEC	3	3	0	0	3
3.	PCU103	High Speed Switching and Networking	PEC	3	3	0	0	3
4.	PCU104	Signal Integrity for High Speed Design	PEC	3	3	0	0	3
5.	PCU105	Wavelets and Subband Coding	PEC	3	3	0	0	3

SEMESTER II, ELECTIVE – II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PCU201	Multimedia Compression Techniques	PEC	3	3	0	0	3
2.	PCU202	Cognitive Radio Networks	PEC	3	3	0	0	3
3.	PCU203	Speech Processing	PEC	3	3	0	0	3
4.	PCU204	Millimeter Wave Communication	PEC	3	3	0	0	3

5.	PCU205	Analog and Mixed Signal VLSI Design	PEC	3	3	0	0	3

SEMESTER III, ELECTIVE - III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PCU301	Ultra Wide Band Communications	PEC	3	3	0	0	3
2.	PCU302	VLSI for Wireless Communication	PEC	3	3	0	0	3
3.	PCU303	MEMS and NEMS	PEC	3	3	0	0	3
4.	PCU304	Advanced Antenna Design	PEC	3	3	0	0	3
5.	PCU305	Software Defined Radios	PEC	3	3	0	0	3

SEMESTER III, ELECTIVE - IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PCU401	Image and Video Processing	PEC	3	3	0	0	3
2.	PCU402	Radar Signal Processing	PEC	3	3	0	0	3
3.	PCU403	Telecommunication System Modeling and Simulation	PEC	3	3	0	0	3
4.	PCU404	Signal Detection and Estimation	PEC	3	3	0	0	3
5.	PCU405	Real Time Embedded Systems	PEC	3	3	0	0	3

BASIC SCIENCE COURSE (BSC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA3124	Advanced Mathematics for Communication Engineering	BSC	4	4	0	0	4

PROFESSIONAL CORE COURSES (PCC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CU3161	Statistical Signal Processing	PCC	3	3	0	0	3
2.	CU3162	Modern Digital Communication Systems	PCC	3	3	0	0	3
3.	CU3163	Advanced Wireless Communication	PCC	3	3	0	0	3
4.	CU3164	Radiating Systems	PCC	3	3	0	0	3
5.	DS3162	Machine Learning	PCC	3	3	0	0	3
6.	CU3165	Digital Communication Systems Laboratory	PCC	3	0	0	3	1.5

7.	CU3166	Advanced Digital Signal Processing Laboratory	PCC	3	0	0	3	1.5
8.	CU3261	RF System Design	PCC	3	3	0	0	3
9.	CU3262	Microwave Integrated Circuits	PCC	3	3	0	0	3
10.	CU3263	Advanced Wireless Networks	PCC	3	3	0	0	3
11.	CU3264	Optical Communication and Networking	PCC	3	3	0	0	3
12.	CU3265	Wireless Communication Laboratory	PCC	4	0	0	4	2

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BA3371	Research Methodology and IPR	RMC	2	2	0	0	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CU3246	Mini Project	EEC	4	0	0	4	2
1.	CU3341	Term Paper Writing and seminar	EEC	2	0	0	2	1
3.	CU3342	Project Work Phase - I	EEC	12	0	0	12	6
4.	CU3343	Internship	EEC	0	0	0	0	2
5.	CU3441	Project Work Phase - II	EEC	24	0	0	24	12

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E. COMMUNICATION SYSTEMS					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	BSC	04	00	00	00	04
2.	PCC	18	14	00	00	32
3.	PEC	00	06	06	00	12
4.	RMC	00	00	03	00	03
5.	EEC	00	2	09	12	23
6.	**TOTAL CREDIT**	**22**	**22**	**18**	**12**	**74**

MA3164 ADVANCED MATHEMATICS FOR COMMUNICATION ENGINEERING

L	T	P	C
4	0	0	4

OBJECTIVES:

- To encourage students to develop a working knowledge of the ventral ideas of linear algebra.
- To grasp the basic concepts of Probability, Random variables, correlation and regression.
- To characterize the phenomena which evolve with respect to random processes
- To acquire skills in analyzing Queueing Models
- To develop a fundamental understanding of linear programming models and apply the simplex method for solving linear programming problems

UNIT-I: LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigen values using QR transformations – QR factorization – Generalized eigenvectors – Jordan Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT-2: PROBABILITY AND RANDOM VARIABLES 12

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

UNIT-3: RANDOM PROCESSES 12

Classification – Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process – Auto correlation – Cross correlation.

UNIT-4: QUEUEING THEORY 12

Markovian queues – Single and multi-server models – Little's formula – Steady state analysis.

UNIT-5: LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method – Transportation problems – Assignment models.

TOTAL: 60 PERIODS

OUTCOMES:

- To apply various methods in Linear Algebra to solve the system of linear equations.
- To use two-dimensional random variables, correlations and regression in solving application problem.
- To apply the ideas of Random Processes.

- To understand the basic characteristic features of a queueing system and acquire skills in analyzing queueing models.
- To apply the Simplex method for solving linear programming problems

REFERENCES:

1. Miller,S.L. and Childers D.G., “Probability and Random Processes with Applications to Signal Processing and Communications”, Academic Press,2004.
2. Friedberg A.H, Insel A.J. and Spence L, “Linear Algebra”, Prentice Hall of India, New Delhi, 2004.
3. T.Veerarajan, “Probability, Statistics and Random Process with Queueing Theory and Queueing Network, Tata McGraw Hill, 4th Edition, 2017.
4. Richard Bronson,”Matrix Operations” Schaum’s outline series, McGraw Hill, 2 nd Edition, New York, 2011.
5. Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M., “Fundamentals of Queueing Theory”, 4th Edition, Wiley, 2014.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	2	3	4	5	6	1	2	3
CO1	3	2	2	1	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-
CO4	3	2	2	1	-	-	-	-	-
CO5	3	2	2	1	-	-	-	-	-
CO6	3	2	2	1	-	-	-	-	-
Average	3	2	2	1	-	-	-	-	-

CU3161	STATISTICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the mathematical description of random signal processing
- To learn the concept of signal modeling and optimum filters
- To estimate the power spectral density of random process.
- To design an adaptive filters for nonstationary signals
- To explore the integration principles of system working with different sampling rates
- To apply the concept of adaptive filter and multirate signal processing for various applications.

UNIT-I: DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes - Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Ergodic process, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes : ARMA, AR, MA models, Yule-Walker equations.

UNIT-II: SIGNAL MODELING AND OPTIMUM FILTERS 9

Introduction- Least square method – Pade approximation – Prony's method – Levinson-Durbin Recursion – FIR Lattice filter - IIR Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Wiener Filter -– Discrete Kalman filter.

UNIT-III: SPECTRAL ESTIMATION 9

Estimation of spectra from finite duration signals, Nonparametric methods – Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods – ARMA, AR and MA model based spectral estimation, Frequency Estimation – Eigen Decomposition of autocorrelation matrix, MUSIC algorithm.

UNIT-IV: ADAPTIVE FILTERS 9

FIR adaptive filters – Steepest descent method LMS algorithm, Convergence , Normalized LMS; Adaptive Recursive Filters; RLS adaptive algorithm-Exponentially weighted RLS - sliding window RLS; Application: channel equalization, noise cancellation, prediction

UNIT-V: MULTIRATE SIGNAL PROCESSING 9

Decimation, Interpolation, sampling rate conversion by rational factor, filter design and implementation for sampling-rate conversion, multistage implementation of sampling-rate converslon, sampling-rate conversion of bandpass signals; application: subband coding of speech signals - quadrature mirror filter.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

- Emphasize the basic theory of random processes used for signal processing
- Present a different approaches to signal modeling and optimum filter for the given problem
- Estimate the power spectrum of random signals in the presence of noise
- Design adaptive filters for processing nonstationary signals of different applications
- Understand the principles of system design that works with subsystems working with different sampling rates
- Propose the system for given application using adaptive filter and multi-rate signal processing

REFERENCES:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc, Singapore, 2002.

2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.
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. S Nandi, D Kundu, Statistical Signal Processing- Frequency Estimation, Springer Nature Singapore, 2ndedition , 2020
6. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Statistical Signal Processing with Applications, PHI, 1996.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COURSE OUTCOMES	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	1	-	2	1	-	-	2	-	-
2	2	1	3	2	1	-	2	-	-
3	3	2	3	2	-	-	2	-	-
4	3	2	3	2	1	-	2	-	-
5	3	2	3	1	1	-	2	1	-
6	3	2	3	2	2	-	2	1	-
Average	2.5	1.8	2.8	1.7	1.3	-	2.0	1.0	-

CU3162	MODERN DIGITAL COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the trade-offs involved in the design of basic and advanced coding and modulation techniques.
- To understand the basics of signal-space analysis and digital transmission.
- To enhance the student knowledge incoherent and non-coherent receivers.
- To enable the student to learn about Equalizers.
- To develop the student knowledge in different block codes and convolutional codes.
- To learn the basic concepts about multi carrier modulation techniques.

UNIT-I: COHERENT AND NON-COHERENT COMMUNICATION 9

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

UNIT-II: EQUALIZATION TECHNIQUES 9

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

UNIT-III: BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; Orthogonal; Bi-orthogonal; Transorthogonal – Shannon"s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT-IV: CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

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 SYSTEMS 9

OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; Peak to Average Power reduction schemes; Overview of GFDM, FBMC, UFMC, Multicarrier CDMA.

TOTAL : 45 Periods

COURSE OUTCOMES:

On Completion of the course the student will be able to

- Demonstrate an understanding of the trade-offs involved in the design of modulation signals.
- Explain the basic signal-space analysis and digital transmission.
- Analyze the operation of coherent and non-coherent receivers.
- Describe the basic operation of Equalizers
- Design the different block codes and convolutional codes.
- Apply the knowledge on Multicarrier and Multiuser Communications

REFERENCES:

1. Bernard Sklar., “Digital Communications” , Pearson Education, 3rd Edition, 2001.
2. John G. Proakis., “Digital Communication”, Mc Graw Hill Publication, 5th Edition, 2001.
3. M.K.Simon, S.M.Hinedi and W.C.Lindsey, “Digital communication techniques; Signal Design and Detection”, Prentice Hall of India, New Delhi, 1999.
4. Stephen G. Wilson, “Digital Modulation and Coding”, First Indian Reprint, Pearson Education, 2003.
5. Simon Haykin, “Digital communications”, John Wiley and sons, 1998.

6. Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications” Artech House Publication, 2001.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	1	2	3	4	5	6	1	2	3
CO1	3	-	2	1	3	2	3	3	2
CO2	3	-	3	2	3	2	3	3	2
CO3	3	-	2	2	3	2	3	3	2
CO4	3	-	3	2	3	2	3	3	2
CO5	3	-	2	2	3	2	3	3	2
CO6	3	-	3	2	3	2	3	3	2
Average	3.0	-	2.5	1.8	3.0	2.0	3.0	3.0	2.0

CU3163	ADVANCED WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To learn the concepts of Wireless Communication.
2. To study the fundamentals of propagation models.
3. To know about the various propagation methods
4. To understand Channel models and Capacity calculations.
5. To learn the capacity improvement of wireless channel using MIMO.
6. To study about Multi user system.

UNIT-I: WIRELESS CHANNEL PROPAGATION AND MODELS 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, Composite Fading –shadowing Distributions, Link power budget Analysis.

UNIT-II: CAPACITY OF WIRELESS CHANNELS 9

Capacity in AWGN, Channel capacity theorem, capacity of flat fading channels, capacity of frequency selective fading channels. Key factors affecting channel capacity, Channel state information, Channel capacity optimization techniques.

UNIT-III: DIVERSITY TECHNIQUES 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

Review of Multiple Access Techniques, Scheduling, power control, Uplink and Downlink channel capacity, multiuser diversity, MIMO-MU systems.

TOTAL : 45 Periods

COURSE OUTCOMES:

On the completion of the course, the student will be able to:

1. Analyze the wireless channel characteristics and identify appropriate channel models
2. Explore the mathematics behind the capacity calculation under different channel conditions.
3. Understand the implication of diversity combining methods and the knowledge of channel
4. Understand the concepts in MIMO Communications
5. Understand multiple access techniques and their use in different multi-user scenarios.
6. Understand the principles of Multi-User system Concept.

REFERENCES:

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2012.
2. Harry R. Anderson, “Fixed Broadband Wireless System Design”, John Wiley, India, 2003.
3. Andreas.F. Molisch, “Wireless Communications”, John Wiley, India, 2006.
4. Simon Haykin & Michael Moher, “Modern Wireless Communications”, Pearson Education, 2011.
5. Gordon L. Stuber, “Principles of Mobile Communication”, Springer International Ltd., 2017.

6. Upena Dalal,Manoj K.Shukla, “Wireless and Mobile Communication”, Oxford Higher Education, 2016.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	2	2	-	-	2	-	2
CO2	1	-	2	2	-	-	2	3	2
CO3	1	-	2	2	-	-	-	1	1
CO4	1	-	2	3	-	-	-	-	1
CO5	1	-	2	3	1	1	1	-	-
CO6	1	-	3	2	-	1	-	1	1
Average	1.0	-	2.2	2.3	1.0	1.0	1.7	1.7	1.4

CU3164	ADVANCED RADIATING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand antenna basics and its parameters.
- To understand wire antennas radiation.
- To enhance student knowledge in the area of various antenna design.
- To learn about antenna arrays and their characteristics.
- To familiarize with modern antennas and measurements.
- To learn about recent trends in antenna design.

UNIT-I: ANTENNA FUNDAMENTALS AND WIRE ANTENNAS 9

Introduction, Types of Antennas, Radiation Mechanism, Current distribution on wire antennas, Maxwell‘s equations, Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions, Dipole, Monopole, Loop antenna.

UNIT-II: APERTURE ANTENNAS 9

Field equivalence principle, Radiation from rectangular and circular apertures, Babinet’s principle, Slot antenna; Horn antenna; Reflector antenna, Aperture blockage and design consideration, Radiation mechanism and excitation techniques, Microstrip dipole; Patch, Rectangular patch, Circular patch, Feed network, Lens Antennas.

UNIT-III: 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, Smart antennas, Switched beam and adaptive arrays, Mutual coupling in finite arrays.

UNIT-IV: MODERN ANTENNAS AND MEASUREMENT TECHNIQUES 9

Base station antennas, PIFA, Antennas for WBAN, RFID Antennas, Automotive antennas, MIMO Antennas, Diversity techniques, Antenna Measurements-Test sites and anechoic chamber, Measurement of VSWR, Impedance, Polarization Gain, Radiation pattern.

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, Optical antennas, Antennas for millimeter wave communication, Optimization techniques, Numerical methods.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Analyze the fundamentals behind antenna radiation mechanism and its parameters.
- Understand the challenges associated in designing antennas based on different technologies.
- Apply the capability and assess the performance of various antennas.
- Identify the antennas specific to the applications, design and characterize.
- Assess the need for optimizing in antenna design and the methodologies for the same.
- Design various types of antenna based on application.

REFERENCES:

1. Balanis.A, “Antenna Theory Analysis and Design”, 4th Edition, John Wiley and Sons, New York, 2016.
2. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, “Antennas and Wave Propagation”, 5th Edition, Tata McGraw-Hill, 2017.
3. Hubregt.J.Visser “Antenna Theory and Applications”, 1st Edition, John Wiley & Sons Ltd, New York, 2012.

4. S.Drabowitch et.al., ”Modern Antennas”, 2nd Edition, Springer science business Media Inc., 2005.
5. Xavier Begaud, “Ultra Wide Band Antennas”, 1st Edition, ISTE Ltd and John Wiley &Sons Ltd, New York, 2013.
6. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
7. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, John Wiley& Sons Inc., 3rd Edition, 2012.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	3	3	3	2	-	-	2	-	-
2	3	3	3	3	-	-	2	-	-
3	3	3	3	-	-	-	2	-	2
4	3	2	3	2	-	2	3	2	2
5	3	3	2	3	-	-	2	2	2
6	3	2	3	2	-	2	-	2	2
Average	3.0	2.7	2.8	2.4	-	2.0	2.2	2.0	2.0

DS3162 **MACHINE LEARNING TECHNIQUES** **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the basic concepts and techniques of Machine Learning.
- To appreciate supervised and unsupervised learning and their applications
- To understand the theoretical and practical aspects of Probabilistic Models
- To appreciate the concepts and algorithms of reinforcement learning
- To learn aspects of computational learning theory

TECHNIQUES:

- To study the various probability based learning techniques.
- To understand graphical models of machine learning algorithms.

UNIT – I: INTRODUCTION **9**

Learning – Machine Learning Foundations –Overview – Design of a Learning system - Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants –Linear Separability – Linear Regression.

UNIT - II: LINEAR MODELS **9**

Linear model for classification - Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT - III: TREE AND PROBABILISTIC MODELS **9**

Decision trees – learning decision trees – Constructing Decision Trees -ranking and probability estimation trees – Regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first -order rule learning- Gaussian Mixture Models- Nearest Neighbor Methods –K means Algorithms- Vector Quantization – Self Organizing Feature Map.

UNIT - IV: EVOLUTIONARY AND GRAPHICAL MODELS **9**

Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms –Markov Chain Monte Carlo Methods – Sampling – Proposal

Distribution – Markov Chain Monte Carlo – Graphical Models – Directed graphical models- Undirected graphical models- Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

UNIT - V: ADVANCED LEARNING 9

Sampling –Basic sampling methods- Monte Carlo- Reinforcement Learning- Model-Based Learning- Temporal Difference Learning Exploration Strategies- Deterministic and Non-deterministic Rewards Actions Computational Learning Theory - Mistake bound analysis, sample complexity analysis, VC dimension. Occam learning, applications in game playing – applications in robot control.

OTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the appropriate machine learning strategy for any given problem
- Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
- Design systems that uses the appropriate graph models of machine learning
- Modify existing machine learning algorithms to improve classification efficiency
- Identify applications suitable for different types of machine learning with suitable justification

REFERENCES:

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
2. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
3. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.
4. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
5. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
6. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2011.
7. Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Chapman and Hall/CRC Press, Second Edition, 2014.

OURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	3	3	3	3	2	3	3	3	-
2	3	3	3	3	2	3	2	2	-
3	3	3	3	3	2	3	2	2	-
4	3	3	3	3	2	3	2	2	-
5	3	3	3	3	2	3	2	2	-
6	-	-	-	-	-	-	-	-	-
Average	3.0	3.0	3.0	3.0	2.0	3.0	2.2	2.2	-

CU3165	DIGITAL COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To study & measure the performance of digital communication systems.
- To explore the modulation schemes used in Wireless Communication.
- To learn about the design of digital filter.
- To enable the student to learn about adaptive filtering algorithms.
- To develop the student knowledge in error control codes.
- To design and conduct experiments on software defined radio.

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Performance Evaluation of digital modulation schemes
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. Digital Filter Design.
4. CDMA signal generation and RAKE receiver design using MATLAB/ SCILAB/LABVIEW
5. Channel equalizer design – LMS
6. Channel equalizer design – RLS
7. OFDM transceiver design
8. Design and performance analysis of error control encoder and decoder (Block and Convolutional Codes)
9. Noise / Echo cancellation using MATLAB
10. Wireless channel characterization.

TOTAL : 60 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

- Generate and detect digital communication signals of various modulation techniques using MATLAB.
- Analyze the performance of various digital communication systems.
- Design the basic channel equalizers.

- Observe and analyze the filtering algorithms in the communication.
- Apply the knowledge on OFDM.
- Acquire knowledge in error control codes.

LAB REQUIREMENTS:

(Requirements for a batch of 18 students)

S.No	Description of Equipment	Quantity Required
1	Spectrum Analyzer (min 1GHz)	1 No.
2	Digital Storage Oscilloscope	10 Nos.
3	PC with MATLAB/ Scilab / equivalent software (user license)	10 Nos

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	1	2	3	4	5	6	1	2	3
CO1	2	-	3	2	3	2	3	3	3
CO2	2	-	3	3	3	2	3	3	3
CO3	2	-	3	2	3	2	3	3	3
CO4	2	-	2	3	3	2	3	3	3
CO5	2	-	3	3	3	2	3	3	3
CO6	2	-	3	3	3	2	3	3	3
Average	2.0	-	2.8	2.7	3.0	2.0	3.0	3.0	3.0

CU3166	ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To perform random signal processing operations and implement in simulation tool.
- To analyze the frequency response of filters using signal processing method
- To detect signal in the presence of noise using optimum filter
- To estimate and implement the power spectral density of random process
- To design and implement the adaptive filters for nonstationary signals
- To demonstrate and verify the upsampling and down sampling of signals

LIST OF EXPERIMENTS (Using Simulation Tool)

1. Generate the auto correlation sequence of random sequence for Gaussian noise and uniform white noise (N=100 samples).
2. Generate an autoregressive, moving average and autoregressive moving average process of unit variance white Gaussian noise (N=100 samples).
3. Design a linear phase low pass filter having a cut-off frequency of π/2 using Pade approximation method and Prony's method.
4. Design of LPC filter using Levinson-Durbin algorithm.
5. Design a FIR Wiener filter to extract a desired signal from the noise corrupted signal.
6. Estimation the PSD of a noisy signal using periodogram and modified periodogram.
7. Estimation of power spectrum of the given random sequence using Nonparametric methods (Bartlett, Welch and Blackman Tukey).
8. Estimation of power spectrum of the given random sequence using parametric methods (AR, MA and ARMA).
9. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using LMS Algorithm.
10. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using RLS Algorithm.
11. Upsampling the discrete time sequence by L times and plot the spectrum of both the given sequence and upsampled sequence.

12 Down sampling the discrete time sequence by M times and plot the spectrum of both the given sequence and down sampled sequence.

TOTAL: 45 Periods

OUTCOMES:

On completion of the course, the student will be able to

- Generate Random sequences and analyzed with processes using simulation tool
- Design and analyze the frequency response of filters for the given specification using signal processing method
- Detect signal in the presence of noise using optimum filter
- Estimate power spectrum of the given random sequence using parametric/nonparametric estimation methods
- Implement adaptive filters using LMS/RLS algorithm
- Demonstrate the discrete time systems at various sampling rates

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COURSE OUTCOMES	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	1	-	2	3	-	-	2	-	-
2	2	-	3	3	1	-	2	-	-
3	3	-	3	3	-	-	2	-	-
4	3	-	3	3	1	-	2	-	-
5	3	-	3	3	1	-	2	1	-
6	3	-	3	3	2	-	2	1	-
Average	2.5	-	2.8	3.0	1.3	-	2.0	1.0	-

CU3261	CMOS VLSI DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

1. To infer the operation and characteristics of MOS Transistors.
2. To understand the construction, operation, and characteristics of CMOS Inverter.
3. To provide a platform for transistor level digital circuits design.
4. To design the Combinational and Sequential circuits using CMOS Technology.
5. To learn the basic building blocks of analog integrated circuit design.
6. To identify the design procedure of MOS single stage amplifiers.

UNIT I MOS TRANSISTOR AND CMOS INVERTER 9

MOS Transistor: MOS Structure – Analysis under External Bias. MOS (NMOS/PMOS) Transistor - Structure and Operation – Static and Dynamic Characteristics. Physical Design – Layout Design Rules, Layout and Stick Diagram of NMOS and PMOS Transistors. Fabrication Process of NMOS and PMOS Transistors.

CMOS Inverter: Static and Dynamic CMOS Inverter – Construction, Operation and Characteristics. Physical Design – Layout and Stick Diagram of CMOS Inverter. Fabrication - n- well CMOS, p-well CMOS and twin-tub CMOS. Design of CMOS Inverter - Inverter Design with Delay Constraints. Source of Power Consumption - Power and Delay Trade-offs.

UNIT II CMOS COMBINATIONAL CIRCUITS 9

Static CMOS Logic Circuits - Construction and Operation. Design Examples: Basic Gates, Complex Logic Circuits. Ratioed Logic – Pseudo-nMOS Logic, DCVSL logic gate, Pass-Transistor Logic. Transistor Sizing. Transmission Gates – Construction and Operation. Design Examples: Basic Gates, Complex Logic Circuits. Dynamic CMOS Logic Circuits – Basic Dynamic Logic – Non-ideal Effects of Dynamic Logic - Domino Logic.

UNIT III CMOS SEQUENTIAL CIRCUITS 9

Timing Metrics for Sequential Circuits – Timing Issues in Sequential Circuits. D Flipflops - Static and Dynamic, Transmission Gate Based Registers, Clocked CMOS Registers, True Single-Phase Clocked Register (TSPCR), Register Pipelining, Latch vs Register Based Pipelines, NORA – CMOS. Memory Architecture and Building Blocks, Memory Core, Read Only Memories (ROMs), Read Write Memories (RAMs) – CMOS Implementations.

UNIT IV BASIC BUILDING BLOCKS OF CMOS ANALOG IC 9

Switches – Active Resistors - Current Sources and Sinks, Current Mirrors and Amplifiers. Voltage and Current References, Bandgap Reference Circuits.

UNIT V CMOS AMPLIFIERS 9

Inverting Amplifiers - General Concepts, MOS Inverting Amplifiers. Improving Performance of Inverting Amplifiers - Current Driven and Voltage Driven CMOS Cascode Amplifiers - Improving Gain of CMOS Cascode Amplifier. CMOS Differential Amplifiers – Frequency Response and Noise Performance. Output Amplifiers with and without Feedback.

TOTAL PERIODS: 45

COURSE OUTCOMES

On completion of the course, the student will be able to

1. Understand the construction and operation of MOS Transistor and CMOS Inverter.
2. Examine the working of CMOS Inverter logic.
3. Describe Combinational Logic Circuits using CMOS technology.
4. Design Sequential Logic Circuits using CMOS technology.
5 Construct the basic building blocks of Analog Integrated Circuit.
6. Analyse the performance of different CMOS Amplifiers.

REFERENCES:

1. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim, CMOS Digital Integrated Circuits: Analysis and Design, Fourth Edition, McGraw Hill Education, 2015
2. Neil H. E. Weste, David Money Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Fourth Edition, 2015 Pearson India.
3. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits: ADesign Perspective, Second Edition, Prentice Hall of India, 2003.
4. Randall L. Geiger, Philip E. Allen and Noel R. Strader, VLSI Design Techniques for Analog and Digital Circuits, McGraw Hill, 2012.
5. Jacob Baker R, CMOS: Circuit Design, Layout and Simulation, 3rd Edition, Wiley Publications, 2012.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	1	3	3	1	1	1	1	2
CO2	1	1	3	3	1	1	1	1	2
CO3	1	1	3	3	1	1	1	1	2
CO4	1	1	3	3	1	1	1	1	2
CO5	1	1	3	3	2	2	1	1	3
CO6	1	1	3	3	2	2	1	1	3
Average	1.0	1.0	3.0	3.0	1.3	1.3	1.0	1.0	2.3

CU3262	RF AND MIC	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize with the basic fundamentals of RF radio system design.
- To describe the various passive and active components of radio frequency circuits.
- To analyze the biasing methods for RF amplifier
- To explain RF components and design techniques of filters, amplifiers and Mixers.
- To design and analyze the amplifier using the Smith chart
- To understand the microwave IC design

UNIT-I: CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES **9**

CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step-up conversion schemes.

UNIT-II: INTRODUCTION TO RF DESIGN **9**

Importance of RF design, Electromagnetic Spectrum, RF behavior of passive Components, Chip components and Circuit Board considerations, Scattering Parameters, Smith Chart and applications.

UNIT-III: ACTIVE RF COMPONENTS AND APPLICATIONS **9**

RF diodes, BJT, RF FETs, High electron mobility transistors; Matching and Biasing Networks – Impedance matching using discrete components, Microstrip line matching networks, Amplifier classes of operation and biasing networks.

UNIT-IV: RF FILTER DESIGN, MIXER AND RF AMPLIFIER DESIGNS 9

Basic resonator and filter configuration, special filter realizations, filter Implementation, Amplifier power relations, Stability considerations, Constant gain circles, Constant VSWR circles, Broadband, high power and multistage amplifiers. Basic characteristics of mixers.

UNIT-V: MIC COMPONENTS 9

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, Coplanar microwave amplifiers: LNA design and Medium power amplifiers

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student should be able to:

1. Get the basic knowledge of different Transceiver Specifications and Architecture
2. Understand the basic tools required for RF design
3. Design of amplifiers using Smith chart at RF and microwave frequencies.
4. Analyze the microstrip line filters and their realizations.
5. Design of mixers and control circuits at RF and microwave frequencies.
6. Perform simulations, fabricate and test microwave devices.

REFERENCES:

1. B.Razavi, “RF Microelectronics”, 2nd edition, Pearson Education, 2012.
2. T. Lee, “Design of CMOS RF Integrated Circuits”, Cambridge University, 2004.
3. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications”, 1st Edition, Pearson Education Asia, 2011.
4. Joseph. J. Carr, “Secrets of RF Circuit Design”, McGraw Hill Publishers, Third Edition, 2000.
5. Matthew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education, 2015.

6. David M. Pozar, “Microwave Engineering”, John Wiley & Sons, 4th edition 2013.
7. Jia Sheng Hong, M. J. Lancaster, “Microstrip Filters for RF/Microwave Applications”, John Wiley & Sons, 2001.
8. Ulrich L. Rohde and David P. Newkirk, “RF / Microwave Circuit Design”, John Wiley & Sons USA 2000.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	3	2	2	2	-	-	2	2	2
2	3	3	3	3	-	-	2	1	2
3	3	3	3	2	-	-	2	-	2
4	3	3	3	3	-	-	2	-	2
5	3	3	3	3	-	-	2	-	2
6	3	3	3	2	-	-	2	-	2
Average	3.0	2.8	2.8	2.5	-	-	2.0	1.5	2.0

CU3263	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To study about advanced wireless networks, LTE, 4G and Evolutions from LTE to LTE.
2. To study about wireless IP architecture, Packet Data Protocol and LTE network architecture
3. To learn about adaptive link layer, hybrid ARQ and graphs routing protocol.
4. To become familiar with mobility management, cellular network, and micro cellular networks
5. To know about QoS challenges and attributes in various advanced wireless networks
6. To analyse the role of Interference management and mobility management in 5G.

UNIT - I: INTRODUCTION TO WIRELESS NETWORKS **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, The requirements of 5G technology, Interference management in 5G.

UNIT- II: MOBILITY MANAGEMENT **9**

Cellular Networks - Cellular Systems with Prioritized Handoff - Cell Residing Time Distribution - Mobility Prediction in Pico- and Micro-Cellular Networks, Mobility management in heterogeneous 5G networks.

UNIT- III: WIRELESS IP NETWORK ARCHITECTURES **9**

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 – Bearer Establishment Procedure -Inter-working with other RATs.

UNIT-IV: 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.

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:

On completion of the course, the student will be able to

1. Cope up with the latest 4G networks and LTE.
2. Explain the wireless IP architecture and LTE network architecture.
3. Illustrate the adaptive link layer and network layer graphs and routing protocols.
4. Describe the mobility management and cellular network.
5. Analyze the QoS challenges and attributes of various advanced wireless networks.
6. Demonstrate the advanced wireless network solutions in a global, economic, environmental and societal context.

REFERENCES:

1. Savo Glisic, “Advanced Wireless Networks-Technology and Business Models”, Third Edition, John Wiley & Sons Ltd, 2016.
2. Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, “Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach”, John Wiley & Sons, 2014.
3. Crosspoint Boulevard, “Wireless and Mobile All-IP Networks”, Wiley Publication, 2005.
4. Jyh-Cheng Chen and Tao Zhang, “IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols”, John Wiley & Sons, Inc. Publication,2006.
5. Minoru Etoh, “Next Generation Mobile Systems3G and Beyond,” Wiley Publications,2005.
6. Savo Glisic,”Advanced Wireless Networks-4G Technologies”, John Wiley & Sons, Ltd,2006.

7. StefaniaSesia, IssamToufik and Matthew Baker, “LTE – The UMTS Long Term Evolution From Theory to Practice”, John Wiley & Sons, Inc. Publication, Second Edition, 2011.
8. Jingming Li Salina, Pascal Salina "Next Generation Networks-perspectives and potentials" Wiley, January 2008.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	2	2	1	1	-	3	1	1
CO2	3	2	3	2	1	-	3	3	1
CO3	3	2	1	3	-	-	3	3	3
CO4	2	2	2	2	1	-	3	1	3
CO5	3	2	2	3	2	2	3	1	3
CO6	3	2	2	3	3	3	3	1	3
Average	2.8	2.0	2.0	2.2	1.3	2.0	2.8	1.8	2.2

CU3264	OPTICAL COMMUNICATION AND NETWORKING	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the basic principles of operation of optical network systems and its components.
2. To get the knowledge for designing a fiber optic system addressing the channel impairments.
3. To learn the different network architectures and issues associated with network design.
4. To enable the student to understand the differences in the design of data plane, control plane, routing, switching and the resource allocation methods.
5. To explore the student about different optical modulation schemes and coherent detection.
6. To expose the student to the advances in optical network management and protection techniques.

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, Power penalty, Transmitter, Receiver, Cross talk, Fiber nonlinearities, Dispersion compensation, Wavelength stabilization, Overall Design Considerations.

UNIT-II: 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 Sub-layers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays, Generalized Multiprotocol Label Switching, FTTH Network Architecture, FSO Architecture.

UNIT-III: 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-IV: 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; Demodulation schemes – Homodyne, Heterodyne – Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

UNIT-V: OPTICAL NETWORK SURVIVABILITY **9**

Protection and Restoration Objectives, Fault Protection and Restoration Techniques in the Logical 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, Survivability Techniques for Multicast Connections.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.
2. Apply his knowledge for designing a fiber optic system addressing the channel impairments.
3. Familiar with the architectures and the protocol stack in optical networks.
4. Understand how connections are managed in the network and the pros and cons of the different approaches.
5. Appreciate the need for network survivability and the methodologies used.
6. Identify a suitable backbone infrastructure for our present and future communication needs.

REFERENCES:

1. Rajiv Ramaswami and Kumar N.Sivarajan, “Optical Networks: A Practical Perspective”, Morgan Kauffman Publishers, Third Edition 2010.
2. Thomas E.Stern, Georgios Ellinas, Krishna Bala, “Multiwavelength Optical Networks – Architecture, Design and control”, Cambridge University Press, 2nd Edition, 2009.
3. Uyless Black, “Optical Networks-Third Generation Transport Systems”, Pearson Education, 2008.
4. C.Siva Ram Murthy & M.Gurusamy, ‘WDM Optical Networks’ Pearson Education, 2009.
5. J.Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 3rd Edition, 2008.
6. Biswanath Mukherjee, “Optical WDM Networks”, Springer, 2006.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	PROGRAM OUTCOMES						PSO’s		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	1	1	-	-	3	1	1
CO2	3	-	2	3	-	-	3	2	3
CO3	2	1	3	2	1	-	3	3	3
CO4	1	-	2	2	-	-	3	-	1
CO5	1	-	2	2	1	-	3	1	1
CO6	2	1	3	2	2	1	3	-	2
Average	1.8	1.5	2.0	2.0	1.0	-	2.8	1.8	1.8

PCU101	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain a broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility.
- To understand the ways of mitigating EMI by using shielding, grounding and filtering.
- To realize the concepts of PCB tracing, termination and implementation.
- To impart the knowledge on how EMI impacts wireless and broadband technologies.
- To Introduce the concepts of the various EM radiation measurement techniques
- To provide the insight on different standards being followed across the world in the fields of EMI/EMC.

UNIT-I: EMI NOISE SOURCES, EMI ANALYSIS 9

Definition of EMI and EMC, Sources and Simulators, Propagation Methods, Electromagnetic environment, Frequency spectrum conservations, Electrical Noise Sources, Common-Mode and Differential-Mode Currents

UNIT-II: INTERFERENCE CONTROL TECHNIQUES 9

Equipment screening, Cable screening, Grounding, Shielding effectiveness, Power-line filters, Isolation, Balancing, Signal-line filters, Nonlinear protective devices.

UNIT-III: PCB TRACE ROUTING AND TERMINATIONS 9

Typical PCB Trace Topologies, Trace Routing Design Guidelines, Routing Differential Pair Signals, Layer Jumping – Use of Vias, Routing over a Split Plane, Fundamental Concepts of Trace Termination, Termination Methodologies and Implementation

UNIT-IV: 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.

UNIT-V: EMC STANDARDS AND MEASUREMENTS **9**

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

TOTAL: 45 Periods

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

- Understand and Gain basic knowledge of problems associated with EMI and EMC from electronic circuits and systems.
- Analyze the functions of a ground, understanding about cables and connectors.
- Understand the concepts of PCB tracing, termination and implementation
- Discuss the impact of EMC on wireless and broadband technologies
- Apply the knowledge gained in selecting proper gadgets/devices/ application/ Systems as per EMC norms specified by regulating authorities.
- Explain the need for standards and EMC measurement methods.

REFERENCES:

1. Clayton R Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, Second Edition, 2010.
2. H. W. Ott, Electromagnetic Compatibility Engineering, 2nd edition, John Wiley & Sons, 2011.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition, 2010.
4. Ralph Morrison, "Grounding and Shielding: Circuits and Interference", John Wiley & Sons, 6th Edition, 2016.

5. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
6. Electromagnetic Interference and Compatibility", IMPACT series, IIT-Delhi, Modules1-9.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	POs						PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	2	2	1	1	1	3	2	2
CO2	3	2	2	2	-	1	3	2	2
CO3	3	3	2	2	-	1	3	-	2
CO4	3	3	2	3	2	2	3	-	3
CO5	3	3	3	3	2	1	3	-	3
CO6	3	3	2	2	1	1	3	-	3
Average	3.0	2.7	2.2	2.2	1.5	1.2	3.0	2.0	2.5

PCU102 ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

The students should be made to be

1. To learn the overview of satellite communication
2. To learn M2M developments and satellite applications
3. To understand satellite communication in IPv6 Environment
4. To study about the navigation and Global Positioning System
5. To study about deep space networks and inter planetary missions
6. To explore the summary of various missions and space crafts

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

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT-II: M2M 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 - Key results and recommendations.

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

Over view of Radio and Satellite Navigation, GPS Principles, 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.

TOTAL:45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

1. Understand the basic principles of satellite-based communication.
2. Realize M2M communications and satellite communications.
3. Categorize the different communication in IP environment.
4. Understand the satellite navigation and global positioning system.
5. Outline deep space networks and inter planetary missions.
6. Acquire knowledge mission and space craft summary.

REFERENCES:

1. Anil K. Maini, Varsha Agrawal, ‘Satellite Technology: Principles and Applications’, Third Edition, Wiley, 2014.
2. Daniel Minoli, “Satellite Systems Engineering in an IPv6 Environment”, CRC Press, First Edition, 2009.
3. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, “Global Navigational Satellite Systems” Springer-Verlag, 2008.
4. Adimurthy.V,” Concept design and planning of India’s first interplanetary mission” Current Science, VOL. 109, NO. 6, 1054 25 Sept 2015.
5. Daniel Minoli’ “Innovations in Satellite Communication and Satellite Technology” Wiley, 2015
6. Jim Taylor, “Deep Space Communications” John Wiley & Sons, 2016.
7. Louis J. Ippolito, Jr. “Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance”, Second Edition, 2017
8. http://www.isro.gov.in/pslv-c25-mars-orbiter-mission

9. https://en.wikipedia.org/wiki/Mars_Orbiter_Mission
10. https://en.wikipedia.org/wiki/Chandrayaan-1

COURSE OUTCOMES – PROGRAM OUTCOMES MATRIX

COs	PROGRAMME OUTCOMES (POs)						PROGRAM SPECIFIC OUTCOMES(PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	1	-	-	1	3	3	-
CO2	2	-	3	2	-	2	-	1	2
CO3	2	2	2	2	-	2	3	1	-
CO4	1	2	2	-	-	-	2	2	-
CO5	-	-	2	2	1	-	-	3	1
CO6	2	2	1	1	2	3	2	-	3
Average	1.6	2.0	1.8	1.8	1.5	2.0	2.5	2.0	2.0

PCU103	HIGH SPEED SWITCHING AND NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To learn the basics of switching
2. To evaluate the performance of various switching and router architectures
3. To learn the ATM and MPLS in High-Speed networks
4. To be familiar with the working of queuing, Congestion control and traffic management
5. To explore the QoS and Network Management Protocols and Technologies
6. To observe the various Managing Networks and Applications

UNIT-I: SWITCHING BASICS **9**

Circuit switching - Message switching - Packet switching – Datagrams and Virtual circuits – Cell switching – Label Switching – L2 switching Vs L3 switching, VLANs – Switching and Bridging – Loop resolution - Spanning tree algorithms – Cut through and Store and forw3ard switches – Head of line blocking – Back pressure – Switch design goals.

UNIT-II: SWITCHING AND ROUTING ARCHITECTURES **9**

Shared medium switches – Shared memory switches – Space division switches – Crossbar based switching architecture, Input queued - Output queued and Combined input- Output queued switches, Bus based router architecture with single and multiple processors – Architecture with multiple parallel forwarding engines – Switch based router architecture with multiple processors – Switch based architecture with fully distributed processors.

UNIT-III: HIGH SPEED NETWORKS **9**

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL. MPLS – Layer 2.5 - Labels – Switching and Distribution –Label Switched Path – Label Forwarding Instance Base – Label Stacking - IP Lookup vs Label lookup – Label Distribution Protocol – MPLS based VPNs– Label switching – Label switched path – Comparison with ATM technology.

UNIT-IV: CONGESTION AND TRAFFIC MANAGEMENT **9**

Queuing Analysis- Queuing Models – Single Server Queues, Effects of Congestion – Congestion Control, Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

UNIT-V: NETWORK MANAGEMENT AND APPLICATION **9**

Managing Network - Choosing a Configuration Method - Command Line Interfaces - Graphical User Interfaces - Standardized Data Representations and Access - Making the Choice - Management Information Base (MIB)- Representing Managed Objects, Simple Network Management Protocol (SNMP), Extensible Markup Language (XML), Common Object Request Broker Architecture (CORBA), Choosing a Configuration Protocol - Choosing to Collect Statistics -Common Open Policy Service Protocol (COPS).

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to

1. Outline the principles of High-speed networks.
2. Understand the implementation of Traffic and congestion management.
3. Realize the concepts of TCP and ATM Congestion Control.
4. Explore the importance of QOS support Protocols.
5. Categorize the various network management and its protocols.
6. Acquire the knowledge of various network applications.

REFERENCES:

1. Elhanany, Itamar, Hamdi and Mounir, “High Performance Packet Switching Architectures”, Springer, 2007.
2. H.Jonathan Chao and Bin Liu, “High Performance Switches and Routers”, John Wiley and Sons, 2007.
3. Howard C Berkowitz, “Designing Routing and Switching Architectures for Enterprise Networks”, Sams, 1999.
4. Warland, Pravin Varaiya, “High performance communication networks”, Second Edition, Jean Harcourt Asia Pvt. Ltd., 2001.
5. William Stallings, “High Speed Networks and Internet”, Pearson Education, Second Edition, 2002.
6. Luc De Ghein, “MPLS Fundamentals”, Cisco Press 2014.
7. Damitri P Bertsekas and Gallager, “Data Networks”, 2nd edition, PHI, 1992.
8. Abhijit S. Pandya, Ercan Sea, “ATM Technology for Broad Band Telecommunication Networks”, CRC Press, New York, 2004.

COURSE OUTCOMES – PROGRAM OUTCOMES MATRIX

COs	PROGRAMME OUTCOMES(POs)						PROGRAM SPECIFIC OUTCOMES(PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	2	2	-	-	3	-	-
CO2	1	-	2	2	-	-	2	-	1
CO3	1	2	2	2	-	-	2	1	-
CO4	-	2	2	2	-	2	1	2	-
CO5	-	2	3	2	1	2	1	-	2
CO6	2	2	3	3	2	3	1	-	3
Average	1.3	2.0	2.3	2.2	1.5	2.3	1.7	1.5	2.0

PCU104	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To identify sources affecting the speed of digital circuits.
2. To introduce methods to improve the signal transmission characteristics.
3. To characterize and model multiconductor transmission line.
4. To explore clock distribution system and understand its design parameters.
5. To analysenonideal effects of transmission line.
6. To learn the characteristic impedance of transmission line and impedance matching techniques.

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 Reactiveterminations – L, C, static field maps of micro strip and strip line cross-sections, per unit lengthparameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo andTd equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logicswitching, 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-endcross-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, powerconsumption, 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, Eyediagrams , 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, canceling parasitic capacitance, Clock jitter.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Familiar with transmission line characterization due to high speed signal propagation.
2. Categorize the impairments, crosstalk and non-ideal effects associated with high speed design.
3. Emphasize the sources affecting the speed of digital circuits and their analysis.
4. Understand the power and clock related challenges in high speed system design.
5. Interpret the methods to improve the signal transmission characteristics.
6. Apply the knowledge on understanding of the basic principles of high speed designsignal integrity system and the transmission methodologies.

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 PTR,2012.

3. S. Hall, G. Hall, and J. McCall, “High-Speed Digital System Design: A Handbook ofInterconnect Theory and Design Practices”, Wiley-Interscience, 2014.
4. Eric Bogatin, “Signal Integrity – Simplified”, Prentice Hall PTR, 2010.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	-	1	2	3	-	3	3	3
2	3	2	2	3	1	2	3	1	2
3	3	1	2	3	1	1	3	-	3
4	2	-	2	-	2	-	3	2	1
5	2	2	1	2	-	-	3	-	2
6	2	2	1	-	3	-	3	3	2
Average	2.2	1.7	1.7	2.4	1.8	1.5	3.0	2.0	2.2

PCU105 WAVELETS AND SUBBAND CODING L T P C

3 0 0 3

OBJECTIVES:

1. To introduce the fundamentals concepts of wavelets and subband coding.
2. To develop an understanding of digital signal processing concepts useful for research and design, with a focus on the topics of multirate, multiscale, and time-frequency signal processing/analysis.
3. To provide deeper understanding about multiresolution concept and discrete wavelet transforms.
4. To enable students to use wavelet analysis and subband coding techniques for applications such as image and signal compression, noise reduction, and feature extraction.
5. To expose students to the practical implementation of wavelet and subband coding algorithms.
6. To understand about types of wavelet families & their applications.

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 33 and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured 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: SIGNAL COMPRESSION AND SUBBAND CODING 9

Compression Systems Based on Linear Transforms - Speech and Audio Compression - Image Compression - Video Compression - Joint Source-Channel Coding

COURSE OUTCOMES:

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

1. Explain the basics of wavelet transforms and subband coding.
2. Understand the practical applications of image processing and compression, including medical imaging, video compression, and multimedia communication.
3. Analyze signals and images using wavelet and subband coding techniques.
4. Apply wavelet and subband coding techniques to solve real-world problems in various fields, such as image processing, audio processing, and biomedical signal analysis.
5. Design and implement wavelet and subband coding algorithms for various signal and image processing applications.
6. Evaluate the performance of wavelet and subband coding algorithms in terms of compression ratio, distortion, and computational complexity.

TOTAL: 45 PERIODS

REFERENCES:

1. C.Sidney Burrus, Ramesh A Gopinath & Haitao Guo, “Introduction to wavelets and wavelet transform”, Prentice Hall, 1998.
2. G.Strang and T.Nguyen, “Wavelet and filter banks”, Wesley and Cambridge Press, 1996.
3. Metin Akay, “Time frequency and wavelets in biomedical signal processing”, Wiley-IEEE Press, 1997.
4. M.Vetterli and J. Kovacevic, “Wavelets and Subband coding”, Prentice Hall, 1995.
5. P.Vaidyanathan, “Multi rate systems and filter banks”, Prentice Hall 1993.

6. Raguveer m Rao & Ajith 6. Bopardikar, “Wavelet transforms – Introduction to theory and applications”, Addison Wesley, 1998.
7. S.Mallet, “A Wavelet tour of Signal Processing”, Academic Press 1998.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	2	-	1	1	3	1	-
CO2	-	-	2	1	1	1	2	-	-
CO3	3	-	1	1	1	1	1		1
CO4	1	-	1	3	3	3	1	3	2
CO5	2	-	2	2	3	3	1	2	3
CO6	1	-	1	1	1	1	1	-	2
Average	1.6	-	1.5	1.6	1.7	1.7	1.5	2.0	2.0

PCU201 MULTIMEDIA COMPRESSION TECHNIQUES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
- To enumerate the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To Understand Encoding and Decoding of Digital data streams.
- To analyze the various audio, speech compression techniques.
- To comprehend the use of compression in multimedia processing applications.
- To implement some basic compression standards.

UNIT - I: FUNDAMENTALS OF COMPRESSION 9

Introduction To multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression Algorithms - Elements of Information Theory – Error Free Compression – Lossy Compression.

UNIT - II: TEXT COMPRESSION 9

Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT - III: IMAGE COMPRESSION 9

Image Compression: Fundamentals –– Compression Standards – JPEG Standard – Sub-band coding – Wavelet Based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT - IV: AUDIO COMPRESSION 9

Audio compression Techniques – 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 9

Video compression techniques and Standards – MPEG video coding: MPEG-1 and MPEG2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques –

H.261 Standard – DVI technology – DVI real time compression – Current Trends in Compression standards.

TOTAL PERIODS: 45

COURSE OUTCOMES:

On Completion of the course, the student will be able to

- Implement basic compression algorithms familiar with the use of open-source environments.
- Explain the idea of lossless and lossy compression and the most common file formats for image, sound and video.
- Describe compression, decompression and Motion estimation techniques.
- Design and implement some basic compression standards.
- Critically analyze different approaches of compression algorithms in multimedia applications.
- Implement basic compression algorithms in real time applications.

REFERENCES:

1. Khalid Sayood: Introduction to Data Compression", The Morgan Kaufmann Series in Multimedia Information and Systems, Fourth Edition, 2012.
2. David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlog, New York, 2007.
3. Darrel Hankerson, Greg A Harris, Peter D Johnson, "Introduction to Information Theory and Data Compression", Second Edition, Chapman and Hall, CRC press, 2003.
4. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals", CRC Press, 2003
5. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, 2009.
6. Peter Symes, "Digital Video Compression", McGraw Hill Pub., 2004.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COURSE OUTCOMES	PROGRAM OUTCOMES						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	2	-	2	3	3	3	-	1
2	2	-	-	-	-	-	1	2	3
3	2	-	2	2	-	-	1	2	3
4	2	3	3	3	-	-	3	-	1
5	2	-	3	-	-	-	1	-	3
6	3	3	2	3	3	3	3	-	1
Average	2.2	2.7	2.5	2.5	3.0	3.0	2.0	2.0	2.0

PCU202 COGNITIVE RADIO NETWORKS L T P C

3 0 0 3

OBJECTIVES:

1. To study the evolving software defined radio techniques and their essential functionalities
2. To understand the importance of cognitive radio communication in next Generation networks
3. To analyze the basic architecture and standard for cognitive radio
4. To learn spectrum sensing and dynamic spectrum access
5. To describe the physical, MAC and Network layer design of cognitive radio
6. To expose the student to evolving applications and advanced features of cognitive radio

UNIT - I: INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO 9

Definitions, goals and potential benefits, software radio architecture evolution, Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, enabling technologies, radio frequency spectrum and regulations.

UNIT- II: COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

UNIT-III: SPECTRUM SENSING AND IDENTIFICATION 9

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection, Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing - KullbackLeibler Divergence approach, Fundamental Trade-offs in spectrum sensing

UNIT- IV: MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO 9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

UNIT- V: ADVANCED TOPICS IN COGNITIVE RADIO **9**

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques - Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.

TOTAL: 45 periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Understand the necessity for cognitive radio communication strategies.
2. Describe the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
3. Compare MAC and network layer design for cognitive radio
4. Evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
5. Demonstrate the cognitive radio for Internet of Things and M2M technologies
6. Analyze the impact of the evolved solutions in future wireless network design.

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles And Practice”, Elsevier Inc. , 2010.
2. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, “Cognitive Radio Networks - From Theory to Practice”, Springer Series, Analog Circuits and Signal Processing, 2009.
4. J. Mitola, “Cognitive Radio: An Integrated Agent Architecture for software defined radio”, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
6. Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
7. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	2	2	2	1	1	-	3	-	-
CO2	2	2	3	2	1	-	3	-	-
CO3	3	2	1	2	-	-	3	-	2
CO4	2	2	2	2	1	-	2	1	3
CO5	3	2	2	3	2	2	2	2	3
CO6	3	2	2	3	3	3	2	3	3
Average	2.5	2.0	2.0	2.2	1.6	2.5	2.5	2.0	2.8

PCU203	SPEECH PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To study about the fundamentals of speech and model speech production system.
2. To analyse different speech features.
3. To understand an appropriate statistical speech model for a given application.
4. To learn a speech and speaker recognition system.
5. To study statistical modeling approaches and their implementation issues.
6. To become familiar with build speech synthesis systems.

UNIT-I: BASIC CONCEPTS **9**

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; discrete time model of speech, Short-Time Fourier Transform. Basics of Linear prediction, autocorrelation method, Levinson Durbin algorithm, Pitch estimation using linear prediction analysis.

UNIT-II: FEATURE EXTRACTION **9**

Fundamentals of pattern recognition and significance of feature selection. Homomorphic filtering -Cepstrum. Feature Extraction - MFCC, LPCC and PLP. Speech distortion measures–mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances Likelihood Distortions. Time alignment and normalization - dynamic time warping, multiple time alignment paths.

UNIT-III: SPEECH MODELING **9**

Statistical modeling of speech - Gaussian mixture modeling, Hidden Markov models – Markov processes, HMMs - Probability Evaluation, optimal state sequence - Viterbi search, Baum-Welch parameter re-estimation.

UNIT-IV: RECOGNITION ENGINES 9

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-gram statistics, context dependent sub-word units. Speaker recognition - speaker identification and verification – acoustic models; Applications and current status.

UNIT-V: SPEECH SYNTHESIS 9

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, hidden Markov model-based TTS, context dependent sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and current status.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Emphasize the fundamentals of speech and model speech production system.
2. Present different approaches in build speech synthesis systems.
3. Extract and compare different speech features.
4. Design and implement a speech and speaker recognition system.
5. Acquire knowledge in choosing an appropriate statistical speech model for a given application.
6. Understand the statistical modeling approaches and their implementation issues.

REFERENCES:

1. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, PearsonEducation, 2003.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles andPractice”, Pearson 2012.
3. John Makhoul, “Linear prediction: a tutorial review” –Proceedings of the IEEE, Vol. 63, No. 4,Apr. 1975, pp. 561 – 580.

4. L. R. Rabiner and Schaffer, “Digital Processing of Speech Signals”, Pearson Education, 2013.
5. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing andPerception of Speech and Music”, Wiley- India Edition, 2011.
6. Heiga Zen, Keiichi Tokuda, Alan W. Black, "Statistical Parametric Speech Synthesis", SpeechCommunication, Vol. 51, Issue 11, Nov. 2009, pp. 1039 - 1064.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	1	2	-	2	-	2	-	3
2	3	1	3	3	2	1	3	3	-
3	3	-	3	2	3	1	2	2	3
4	3	3	3	2	-	-	3	2	2
5	2	1	3	3	3	3	3	2	-
6	2	2	3	1	2	-	3	-	2
Average	2.5	1.6	2.8	2.2	2.4	1.7	2.7	2.3	2.5

PCU204	MILLIMETER WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To facilitate understanding of channel behavior at 60 - GHz millimeter wave radios.
- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To provide insights of transceiver architecture in mm-wave communication range.
- To impart knowledge on beam steering and beam forming techniques in multi-antenna array.
- To know the antenna design for mm-wave MIMO systems.

UNIT-I: 60 GHZ MILLIMETER WAVE RADIOS 9

Millimeter Wave characteristics and Implementation Challenges, Channel performance at 60 GHz, Gigabit wireless communication, 60 GHz WLAN standards, Outdoor and Indoor channel models, 60 GHz Market applications.

UNIT-II: MILLIMETER WAVE DEVICES AND CIRCUITS 9

Millimeter wave generation and amplification, HEMT, Transistor configurations, models for mm wave Transistors, Analog mm wave components: Amplifiers, Mixers, PLL.

UNIT-III: MILLIMETER WAVE TRANSCEIVERS 9

Millimeter Wave Link Budget, Transceiver Architecture, Transceiver Without Mixer, Receiver Without Local Oscillator, Millimeter Wave Calibration.

UNIT-IV: ADVANCED BEAM STEERING AND BEAM FORMING 9

The Need for Beam-Steering/Beam-Forming, Adaptive Frame Structure, Advanced Beam Steering Technology, Advanced Antenna ID Technology, Advanced Beam Forming Technology.

UNIT-V: ANTENNAS FOR MILLIMETER WAVE MIMO SYSTEMS 9

Antenna Beamwidth, Polarization, Multiple Antennas, Spatial Diversity, Noise Coupling in a MIMO System, mm-wave design considerations, Potential Benefits for Millimeter Wave Systems, Modulation Allocation.

TOTAL: 45 Periods

COURSE OUTCOMES:

- Understand the Millimeter wave characteristics and implementation challenges faced.
- Develop channel models for millimeter wave systems.
- Explore the knowledge about the Millimeter wave devices and circuits.
- Analyze the transformation techniques & their computation.
- Familiarity with the concepts of diversity and beam forming techniques in millimeter wave systems.
- Gain design ideas on antennas for Millimeter wave frequencies.

REFERENCES:

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, June 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, “Millimeter Wave Wireless Communication", Prentice Hall, 2014.
3. Jonathan Wells, “Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications”, Artech House, 2010.
4. Su-Khiong Yong, Pengfei Xia, Alberto Valdes-Garcia, “60 - GHz Technology for Gbps WLAN and WPAN: From Theory to Practice”, John Wiley & Sons Ltd, 2011.
5. Xiang, W; Zheng, K; Shen, X.S, "5G Mobile Communications: Springer”, 2016.
6. R. Heath and A. Lozano, Foundations of MIMO Communication, Cambridge University Press, 2018.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CO1	3	3	2	2	2	-	3	2	3
CO2	3	3	2	2	2	-	3	2	3
CO3	3	3	3	3	2	-	3	-	3
CO4	3	3	3	3	-	-	3	-	3
CO5	3	3	2	2	1	-	3	-	3
CO6	3	3	2	2	1	-	3	-	3
Average	3.0	3.0	2.3	2.3	1.6	-	3.0	2.0	3.0

PCU205 ANALOG AND MIXED SIGNAL VLSI DESIGN L T P C

3 0 0 3

OBJECTIVES:

1. To study the concepts of MOSFET structures.
2. To analyze the small signal and large signal model.
3. To design the circuit using submicron and basic parameters
4. To understand the concepts of D/A conversion methods and their architectures.
5. To learn filters for ADC.
6. To infer about the switched capacitor circuits.

UNIT-I: INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues- MOSFET 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, polezero estimation, zero value time constant method, frequency response of CS, cascade and Cascode 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 – 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:

On completion of the course, the student will be able to

1. Understand the basic MOS devices characteristics & inspect their frequency responses.
2. Analyze the differences in small signal and large signal modelling.
3. Evaluate with various parameters to design the submicron circuit.
4. Identify the various types of DAC & ADC converters and its conversions.
5. Examine the function of SNR in Data converters.
6. CO6: Apply the knowledge to design 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, 2003.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	3	3	2	3	3	2	1	1	3
2	3	2	2	3	3	2	2	3	3
3	3	1	3	2	3	1	2	2	3
4	3	2	3	2	3	2	2	1	-
5	3	2	2	2	3	1	2	-	-
6	3	1	3	1	3	3	2	-	-
Average	3.0	1.8	2.5	2.2	3.0	1.8	1.8	1.8	3.0

CU3265	WIRELESS COMMUNICATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

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

LIST OF EXPERIMENTS

1	Spectral Characterisation 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 simulation tools.
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

OUTCOMES:

1. Design and conducting experiments to demonstrate the trade-offs involved in the basic and advanced coding and modulation techniques.
2. Understanding the advanced baseband signal conditioning methods.
3. Applying communication engineering principles and design tools.
4. Record and reporting the measured data, write reports and communicate research ideas.
5. Analyzing the measurement data using appropriate techniques.
6. Interpreting the experiments and produce meaningful conclusions.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	1	-	1	2	-	1	2	1	-
CO2	1	-	2	2	2	-	2	1	2
CO3	1	2	1	1	-	-	1	2	-
CO4	1	-	3	3	-	-	-	-	2
CO5	1	-	-	-	1	1	2	1	2
CO6	1	-	2	-	-	1	-	-	-
Average	1.0	2.0	1.8	2.0	1.5	1.0	1.8	1.3	2.0

CU3266	MINI PROJECT	L	T	P	C
		0	0	4	2

OBJECTIVES:

1. Have ability to consolidate the literature search and formulate the problem for the project work.
2. Devise a solution for the problem identification.
3. Design the project to meet specification using the modern tools.
4. Construct and develop the project adhering to the norms and Professional ethics.
5. Contribute to the society as an individual or as a team.
6. Communicate effectively in Project related activities

The student individually must work on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 Periods

COURSE OUTCOMES:

1. Practice acquired knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
3. Reproduce, improve and refine technical aspects for engineering projects.
4. Work as an individual or in a team in development of technical projects.
5. Communicate and report effectively project related activities and findings
6. Function effectively as an individual to deliver an effective presentation.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	-	-	3	2	3
CO2	3	3	3	3	-	-	3	2	3
CO3	3	3	3	3	-	-	3	2	3
CO4	3	3	3	3	-	-	3	2	3
CO5	3	3	3	3	-	-	3	2	3
CO6	-	-	-	-	1	1	3	2	3
Average	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0

BA3371	Research Methodology and IPR	L T P C
		3 0 0 3

OBJECTIVES:

- To familiarise the students with the scientific methodology involved in research process.
- To help students to understand various concepts related to Research design and measurement.
- To learn to design and validate data collection tools.
- To give an idea about IPR, registration and its enforcement.
- To acquaint the students with basics of intellectual property rights

UNIT I INTRODUCTION TO RESEARCH **9**

Introduction of scientific research – the building blocks of science in research – the research process for applied and basic research – the need for theoretical frame work – hypothesis development – hypothesis testing with quantitative data. The research designs. The purpose of the study: Exploratory, Descriptive, Hypothesis testing (Analytical and Predictive) – cross sectional and longitudinal studies.

UNIT II EXPERIMENTAL DESIGN **9**

The laboratory and the field experiment – internal and external validity – factors affecting internal validity. Measurement of variables – scales and measurement of variables – development scales - rating scale and concept in scales being developed. Stability measures.

UNIT III DATA COLLECTION METHOD **9**

Interviewing, questionnaires etc. Secondary sources of data collection. Guidelines for questionnaire design – electronic questionnaire design and surveys. Data-collection methods and when to use each. Sampling techniques and confidence in determining sample size. Hypothesis testing determination of optimal sample size.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY **9**

Introduction - Invention and Creativity - An Overview of Intellectual Property (IP) - Importance - Protection of IPR - Basic types of property. Forms of Industrial Properties: Patents, Industrial Designs, copyrights, Trademarks, Geographical Indications, the way from WTO to WIPO –TRIPS.

UNIT V PATENTS, COPYRIGHTS, TRADEMARKS, OTHER INTELLECTUAL PROPERTY RIGHTS **9**

Introduction to Patents, Procedure for Filing of patents. Acquisition of patent rights. Copyrights and related rights - Trade Marks and rights arising from Trademark registration -Definitions - Industrial Designs and Integrated circuits - PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Trade Secrets.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will get a thorough understanding of how research is conducted in Business Organisation.
- The students will understand the concept of scaling and measurement in management research particularly relating to qualitative data.
- The students will be familiarized with the data collection methods and procedures and make their research studies scientific.
- Skill to understand the concept of intellectual property rights.
- Develops procedural knowledge to Legal System and solving the problem relating to intellectual property rights.

REFERENCES:

1. Ranjit Kumar, Research Methodology, Pearson India, 2005.
2. C.R. Kothari, Gaurav Garg, Research Methodology, New Age International Publishers, 2019.
3. Uma Sekaran and Roger Bougie, Research methods for Business, 5th Edition, Wiley India, New Delhi, 2015.
4. Pandey, Neeraj, Dharni, Khushdeep, Intellectual Property Rights, PHI, 2020.
5. Sople, Vinod V. Managing Intellectual Property: The Strategic Imperative, PHI, 2020.

PO - CO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	-	-	-	-	1	-
CO2	-	2	-	1	-	-	-	-
CO3	1	1	-	-	-	-	-	-
CO4	1	-	-	1	-	-	-	-
CO5		-	-	2	-	-	-	-
Average	1.3	1.5	-	1.3	-	-	1.0	-

PCU301	ULTRA WIDE BAND COMMUNICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts related to ultra wide band communication.
- Estimate the channel models for UWB.
- To understand the signal processing for UWB.
- Acquire knowledge about UWB antennas.
- Analyze the various UWB standards and regulations.
- Explore the applications of ultra wide band.

UNIT-I: INTRODUCTION TO UWB 9

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

UNIT-II: UWB TECHNOLOGIES AND CHANNEL MODELS 9

Impulse Radio, 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, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling.

UNIT-III: UWB SIGNAL PROCESSING 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, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT-V: UWB APPLICATIONS AND REGULATIONS 9

Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries , UWB Regulation in ITU, IEEE Standardization.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to:

- Understand the basic concepts of UWB.
- Elaborate the UWB technologies.
- Assess the performance of UWB channels.
- Analyse various UWB Signal processing techniques.
- Design UWB antenna for various applications.
- Apply UWB regulation and standards in a practical model.

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. Huseyin Arslan, Zhi Ning Chen,Maria-Gabriella Di Benedetto, “Ultra Wideband Wireless communication”, 1st edition, Wiley-Interscience, 2006.
4. Hans G. Schantz, “The Art and Science of Ultrawideband Antennas (Artech House Antennas and Electromagnetics Analysis Library)”, Artech House; 2nd Revised edition, 2015.

5. Chinmoy Saha, Jawad Y Siddiqui, Y M M Antar, “Multifunctional Ultrawideband Antennas: Trends, Techniques and Applications Hardcover”, 1st edition, CRC Press.; 2019.
6. Huseyin Arslan, Zhi Ning Chen,Maria-Gabriella Di Benedetto, “Ultra Wideband Wireless communication”, 1st edition, Wiley-Interscience, 2006

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	3	3	2	-	-	-	2	-	-
2	3	3	2	-	-	-	2	-	-
3	3	2	3	3	-	-	2	-	2
4	3	2	3	-	-	2	3	2	2
5	3	2	3	3	-	2	2	2	2
6	3	2	3	3	-	2	-	2	2
Average	3.0	2.3	2.7	3.0	-	2.0	2.2	2.0	2.0

PCU302	VLSI FOR WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the concepts of basic wireless communication concepts.
2. To study the various design parameters of a receiver architecture.
3. To design the low noise amplifiers.
4. To examine the types of mixers designed for wireless communication.
5. To infer about the working principle of PLL and VCO.
6. To design the back end of a transmitter and power amplifiers for a wireless communication system.

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: Impedance matching & 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 – Dividers – 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Understand the modulation schemes, channel model and access method used for the wireless communication.
2. Explain the receiver architecture in detail.
3. Examine the suitable amplifier the wireless communication.
4. Analyze various types of mixers.
5. Design PLL, oscillators and filters for effective wireless communication.
6. Estimate the acceptable back end transmitter and power amplifier.

REFERENCES:

1. Bosco H Leung “VLSI for Wireless Communication”, 2nd edition, Pearson Education, 2011.
2. B.Razavi ,”RF Microelectronics” , 2nd edtion Prentice-Hall, 2013.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” 2nd edtion, McGraw-Hill, 2017.
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, 2nd edition 2003.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	3	3	2	2	3	2	1	2	-
2	3	2	2	1	2	2	1	1	-
3	3	1	3	2	3	1	1	1	-
4	3	2	3	2	2	2	2	2	-
5	3	2	2	1	2	1	2	2	1
6	3	3	3	1	3	3	2	2	3
Average	3.0	2.2	2.5	1.5	2.5	1.8	1.5	1.7	2.0

PCU303 **MEMS AND NEMS** **L T P C**

3 0 0 3

OBJECTIVES:

1. To introduce the fundamental principles of MEMS and NEMS, including micro and nano-fabrication techniques.
2. To provide an overview of various applications of MEMS and NEMS in areas such as sensing, actuation, communication, and biotechnology.
3. To understand the fabrication techniques for microsystem.
4. To know the design concepts of micro sensors and micro actuators.
5. To familiarize the concepts of Quantum Mechanics and Nano systems.
6. To develop students' ability to design, analyze, and optimize MEMS and NEMS devices and systems, considering performance, reliability, and manufacturability.

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: NANOSYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave Function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their Quantization, Molecular Wires and Molecular Circuits

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the student will be able to:

1. Understand the basics of micro/nano electromechanical systems including their applications and advantages.
2. Gain knowledge of the emerging trends in MEMS and NEMS including microsensors, nano systems and Quantum mechanics.
3. Analyze and optimize the performance of MEMS and NEMS devices and systems.
4. Design simple micro actuators and systems, considering key performance parameters such as sensitivity, bandwidth, power consumption, and noise.
5. Evaluate the advantages and limitations of different MEMS and NEMS fabrication and characterization techniques and select the appropriate ones for specific applications.
6. Apply their knowledge of MEMS and NEMS to real-world problems and challenges, such as designing a biosensor or a microfluidic device.

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, 2nd Edition, Pearson Education India Limited, 2012.
2. Marc Madou, “Fundamentals of Microfabrication”, CRC Press 2011.
3. Stephen D. Senturia,” Micro System Design”, Kluwer Academic Publishers,2002
4. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.

5. Tai Ran Hsu," MEMS and Microsystems Design and Manufacture", Tata Mcraw Hill, 2002.
6. Julian W. Gardner, Vijay K. Varadan, Osama O. Awadel Karim, "Microsensors MEMS and Smart Devices", John Wiley and sons Ltd.,2001.
7. Goser.K , Dienstuhl. J, "Nano Electronics and Nanosystems", Springer International Edition, 2008.
8. Charles P. Poole Jr., Frank J. Ownes , Introduction To Nano Technology , Willey Edition 2008.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	2	-	2	-	2	-	3	-	-
CO2	2	-	2	1	2	2	2	-	1
CO3	2	-	2	1	2	1	1	2	2
CO4	2	-	2	2	3	3	1	1	3
CO5	2	-	1	2	3	3	2	-	1
CO6	3	-	2	1	2	2	1	3	3
Average	2.2	3.0	1.8	1.6	2.5	2.2	1.7	1.7	1.8

PCU304	ADVANCED ANTENNA DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental parameters of an antenna.
- To study the linear antenna and array antenna radiation mechanism.
- To illustrate the features and applications of low profile antenna.
- To explore the methods to analyze the antenna performance.
- To acquire knowledge about modern antennas.
- To analyze the design principles of an antenna.

UNIT-I: ANTENNA FUNDAMENTALS 9

Physical concept of radiation, Antenna parameters, Reciprocity theorem, Friis transmission equation, communication link budget and radar range equation. Review of Electromagnetic Wave equations, Radiation integrals, Radiation from surface and line current distributions- monopole, dipole.

UNIT-II: LINEAR ANTENNAS AND ARRAYS 9

Infinitesimal dipole, finite-length dipole, dipoles for mobile communication, small circular loop, N-Element Linear Array, Linear broadside array and End fire array with uniform spacing, Planar array, Binomial array antennas.

UNIT-III: LOW PROFILE ANTENNAS 9

Microstrip Antenna Elements, Microstrip arrays, Microstrip Leaky Wave antennas, Fundamental limits on antenna size, Antennas for compact devices, Dielectric resonator antennas, Near field of a uniform rectangular aperture, Human body effects on Antenna performance.

UNIT-IV: RADIATION STRUCTURES AND NUMERICAL METHODS 9

Auxillary vector potential, Huygens source approximation, Boundary conditions, Physical optics, Method of Moments, Finite Difference Time Domain Method, Ray Optics and the Geometric theory of Diffraction.

UNIT-V: MODERN ANTENNAS 9

Frequency independent antenna, Phased array antenna, Frequency scanned array antenna, Satellite terminal antenna, smart antenna, Adaptive and Spatial filtering antenna, Wearable antenna, Reconfigurable antenna, Printed antenna, Antenna for wireless charging systems.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

- Explain the antenna parameters and basics of radiation mechanism.
- Comprehend the linear wire antenna and an array antenna characteristics.
- Summarize the characteristics of the low profile antenna and its applications.
- Choose an appropriate method of analysis for studying the performance of an antenna.
- Distinguish the operating principles of the modern antennas.
- Determine the antenna design principles and its applications.

REFERENCES:

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 3rd Edition,1982.
2. Thomas A. Milligan, “Modern Antenna Design”, John Wiley and Sons, New York, 2nd Edition,2005.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, “Modern Antennas”, Springer Publications, 2nd Edition, 2007.
4. R.S.Elliot,"Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.
5. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, John Wiley& Sons Inc., 2nd Edition, 1998
6. Krauss.J.D, “Antennas”, John Wiley and sons, New York, 2nd Edition, 1997.
7. I.J. Bahl and P. Bhartia, “Microstrip Antennas”, Artech House,Inc.,1980

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	-	-	-	-	2	-	2	-	-
2	1	-	-	-	2	-	2	-	-
3	2	-	2	-	2	2	2	-	-
4	2	-	-	3	2	2	2	2	2
5	-	-	2	2	3	2	2	-	-
6	2	-	-	2	2	-	2	2	3
Average	1.8	-	2.0	2.3	2.2	2.0	2.0	2.0	2.5

PCU305	SOFTWARE DEFINED RADIO	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand software defined radio implementation.
- To learn the role of smart antenna and object-oriented real-time software.
- To analyze various multirate signal processing techniques.
- To interpret different RF systems and its implementation.
- To study about digital synthesis of signal.
- To explore digital hardware and software choices.

UNIT-I: INTRODUCTION & CASE STUDIES 9

Introduction to software Radio concepts: Need for software Radios, Definition of software Radio, Characteristics and Benefits. Design Principles. Case studies: SPEAK easy, JTRS.

UNIT-II: RADIO FREQUENCY IMPLEMENTATION 9

The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.

UNIT-III: MULTI RATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS 9

Sample rate conversion principles. Digital filter Banks. Timing recovery in Digital Receivers using Multi rate Digital filters. Approaches to Direct Digital Synthesis. Analysis of spurious signal Band pass signal generation, Generation of Random sequences.

UNIT-IV: SMART ANTENNAS **9**

Vector channel modelling-Benefits of smart antenna-Structures for beamforming system-Smart antenna algorithm-Diversity and space-time adaptive signal processing.

UNIT-V: DIGITAL HARDWARE AND SOFTWARE CHOICES **9**

DSP Processors, FPGA, ASIC's. Tradeoffs, Object oriented programming, Object Brokers, GNU Radio-USRP- SDR-3000 digital transceiver subsystem.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course the student will be able to

- Demonstrate the deep insight in the evolving Software defined radio and technologies for its implementation.
- Analyze the complex problems critically in the domains of Radio frequency implementation issues.
- Apply the multirate signal processing in SDR
- Implement the smart antenna techniques for better spectrum exploitation for conducting research.
- Apply the appropriate techniques for the development of scientific and technological knowledge in designing software defined radios.
- Design of model based on various applications and requirements.

REFERENCES:

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. Tony J Rouphael, "RF and DSP for SDR," Elsevier Newnes Press, 2008.
4. P. Kenington, "RF and Baseband Techniques for Software Defined Radio," Artech House, 2005.

5. Dillinger, Madani, Alonistioti (Eds.), Software Defined Radio, Architectures, Systems and Functions, Wiley, 2003.
6. Bard, Kovarik, Software Defined Radio, the Software Communications Architecture, Wiley, 2007.

COURSE OUTCOMES - PROGRAM OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	2	3	4	5	6	1	2	3
CO1	2	1	3	2	3	2	3	-	1
CO2	2	-	2	2	3	2	3	2	2
CO3	3	-	2	3	2	2	2	2	2
CO4	3	2	3	3	2	2	3	2	2
CO5	3	-	3	3	2	2	3	2	2
CO6	2	-	2	2	2	2	-	2	3
Average	2.5	1.5	2.5	2.5	2.3	2.0	2.8	2.0	2.0

PCU401	IMAGE AND VIDEO PROCESSING	L T P C
		3 0 0 3

OBJECTIVES:

- To provide concept of signals and systems frequency domain image filtering and enhancement.
- To analyze the spatial domain image enhancement.
- To explore the concept of image compression techniques.
- To understand the video processing methods
- To learn the video compression standards.

UNIT – I: INTRODUCTION TO DIGITAL IMAGE AND VIDEO PROCESSING **9**

Types of Images Scale of Images - Dimension of Images Digitization of Images Sampled Images Quantized Images Color Images Size of Image Data – Digital video Sampled Video Video Transmission. Basic Gray-Level Image Processing-Basic Binary Image Processing-Basic Tools for Image Fourier Analysis

UNIT - II: IMAGE ENHANCEMENT **9**

Basic Linear Filtering with Application to Image Enhancement-Nonlinear Filtering for Image Analysis and Enhancement-Morphological Filtering for Image Enhancement and Detection-Wavelet Denoising for Image Enhancement

UNIT - III: IMAGE RESTORATION **9**

Basic Methods for Image Restoration and Identification- Regularization in Image Restoration and Reconstruction- Multichannel Image Recovery- Multifiame Image Restoration- Iterative Image Restoration-

UNIT -IV: VIDEO ENHANCEMENT AND RESTORATION **9**

Introduction- Spatiotemporal Noise Filtering- Blotch Detection and Removal- Intensity Flicker Correction- **3-D** Shape Reconstruction from Multiple Views- Image Sequence Stabilization. Mosaicking. and Super resolution.

UNIT - V: IMAGE AND VIDEO ANALYSIS **9**

Image Representations and Image Models- Image and Video Classification and Segmentation- Edge and Boundary Detection in Images- Algorithms for Image Processing

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Understand the concept of signals and systems frequency domain image filtering and enhancement.
- Analyze the spatial domain image enhancement
- Evaluate the concept of image compression techniques.
- Apply the video processing methods
- Remember the video compression standards.

REFERENCES:

1. Ed. Al Bovik "Handbook of Image and Video Processing" , Academic Press, 2000. ISBN 0-12- 119790-5 .
2. Gonzalez and Woods "Digital Image Processing", Addison-Wesley, 2001. ISBN 0201- 18075-8.
3. J. W. Woods "Multidimensional Signal, Image and Video Processing and Coding", Academic Press, 2006. ISBN 0-12-088516-6 2.
4. Y. Wang, J. Ostermann, and Y.-Q. Zhang "Video Processing and Communications", Prentice Hall, 2002. ISBN 0-13-017547-1
5. A.Tekalp "Digital Video Processing", Prentice Hall, 1995. ISBN 0-13-190075-7.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	1	3	3	-	2	-	2	-	2
2	1	2	3	-	1	-	-	-	-
3	1	3	3	-	2	-	-	-	3
4	1	2	3	-	1	-	2	-	3
5	1	3	3	-	2	-	2	-	-
Average	1.0	2.6	3.0	-	1.6	-	2.0	-	2.7

PCU401	RADAR SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the basic principles of radar operation and the types.
2. To learn the impact of the different performance measures in a radar system.
3. To identify various signal processing tools in the design of radar systems.
4. To study radar systems to meet user specified operational goals.
5. To analyse radar signal processing in real time application.
6. To know about the characteristics of radar returns in various operational environments.

UNIT-I: RANGE EQUATION AND TYPES OF RADAR 9

Basic Radar, Radar equation, Radar parameters, Block diagram, Radar frequencies, Types of Radar: CW, Doppler, MTI, FMCW, Pulsed, Tracking Radar. DSP in Radar (MTD1), Radar measurements.

UNIT-II: RADAR SYSTEM CONCEPTS 9

Scattering and RCS, RCS models, propagation, antennas, receivers, Different type of Noise, Noise figure, False alarm & Missed detection, Radar cross section, Transmit/Receive and AntiTransmit/Receive Switches.

UNIT-III: SIGNAL PROCESSING – I 9

Radar Signal Processing Fundamentals –Detection and likelihood ratio, binary detection, matched filtering, radar ambiguity functions, pulse compression and radar waveforms, radar resolution, Detection of radar signals in Noise and clutter, detection of non-fluctuating target in noise, Matched filter response to delayed Doppler shifted signals.

UNIT-IV: SIGNAL PROCESSING – II 9

Doppler Processing, Linear FM Pulse Compression, Waveform diversity, Passive System: Digital compression, SAW pulse compression. Signal processing in Antenna arrays.

UNIT-V: APPLICATIONS OF RADAR SIGNAL PROCESSING 9

Pulse-Doppler radar, CFAR detection, synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), moving target indication (MTI), displaced-phase-center-antenna technique (DPCA), adaptive radar, super resolution (MUSIC), space-time adaptive processing (STAP).

TOTAL : 45 Periods

COURSE OUTCOMES:

1. Emphasizing the basic principles of radar operation and the types.
2. Explore the impact of the different performance measures in a radar system.
3. Presenting the different signal processing tools in the design of radar systems.
4. Design radar systems to meet various user specified operational goals.
5. Ability to model radar returns in various operational environments and analyze performance.
6. Understand the concepts of radar signal processing that works with real time application from multiple perspectives.

REFERENCES:

1. M.I.Skolnik , “Introduction to Radar Systems”, Tata McGraw Hill 2006.
2. Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, 2014.
3. Peyton Z. Peebles, Jr., “Radar Principles”, Wiley India Pvt Ltd, 2007.
4. Nadav Levanon , “Radar Principles”, Wiley – Technology and Engineering Publication, 2004.

5. Nathansan, “Radar design principles-Signal processing and environment”, PHI, 2nd Edition, 2007.
6. Roger J.Sullivan, “Radar foundations for Imaging and advanced concepts”, PHI, 2004.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	2	-	1	2	3	-	3	1	2
2	3	2	2	3	1	2	3	-	2
3	3	1	2	3	1	1	3	2	3
4	2	-	2	-	2	-	3	2	2
5	2	2	1	2	-	-	3	2	2
6	2	2	1	-	3	-	3	-	2
Average	2.3	1.8	1.5	2.5	2.0	1.5	3.0	1.8	2.2

PCU402	TELECOMMUNICATION SYSTEM MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the simulation and modeling methodology.
- To generate and process the random signal.
- To model and simulate .the wireless communication system model.
- To study the effect of different types of channel in the communication system model.
- To estimate the parameters related to the simulation of a model.
- To model a real time communication scenario.

UNIT-I: SIMULATION AND MODELING METHODOLOGY 9

Introduction, Methodology of Problem Solving for Simulation, Basic Concepts of Modeling, Performance Evaluation Techniques, Error Sources in Simulation, Validation, Simulation Environment and Software Issues

UNIT-II: GENERATION AND PROCESSING OF RANDOM SIGNAL 9

Generation of Random Number Generation, White Gaussian Noise, Random Binary Sequences and Random Binary Waveforms, Pseudorandom Binary Sequences, M-ary Pseudo noise Sequences, Correlated Random Sequences, Testing of Random Number Generators.

UNIT-III: SIMULATION OF WIRELESS COMMUNICATION SYSTEM 9

Introduction to Monte Carlo simulation methods, Semi-analytic Techniques, System-Level Simplifications and Sampling Rate Considerations, Methodology for Simulation of the Analog Portion of the System, Summary of Methodology for Simulating the Analog Portion of the System, Estimation of the Coded BER, Estimation of Voice-Quality Metric.

UNIT-IV: MODELING AND SIMULATION OF WAVEFORM CHANNELS 9

Introduction, Wired and Guided Wave Channels, Radio Channels, Multipath Fading Channels, Modeling Multipath Fading Channels, Random Process Models, Simulation Methodology.

UNIT-V: ESTIMATION OF PARAMETERS IN SIMULATION 9

Basic Parameters, Estimating the Average Level of a Waveform, Estimating the Average Power (Mean-Square Value) of a Waveform, Estimating the Probability Density or Distribution Function of the Amplitude of a Waveform, Estimating the Power Spectral Density (PSD) of a Process, Estimating Delay and Phase, Visual Indicators of Performance.

TOTAL : 45 Periods

COURSE OUTCOMES:

On completion of the course, the student will be able to

- Explain the methodology of simulation and modeling.
- Generate and process various random signals.
- Summarize the methodology of various models for wireless communication system.
- Apply knowledge of simulation techniques for designing a communication system with different types of channels.
- Analyze the parameters in simulation of a system model.
- Model and simulate a system so as to match a real time scenario.

REFERENCES:

1. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, Simulation of Communication Systems: 50 Modeling, Methodology and Techniques, Plenum Press, New York, 2001.
2. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore) Pvt. Ltd, 2004.

3. Averill.M.Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill Inc., 2000.
4. K. Hayes, “Modelling and Analysis of Computer Communication Networks”, Plenum Press, 1984.
5. Geoffrey Gorden, System Simulation, Prentice Hall of India, 2nd Edition, 1992.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes						Program Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	2	2	3	-	-	2	-	-
2	2	2	2	2	-	-	2	-	-
3	2	2	2	2	2	-	2	2	2
4	2	2	2	-	-	-	2	-	-
5	2	1	2	-	-	-	2	-	-
6	3	1	2	-	1	-	2	-	2
Average	2.2	1.7	2.0	2.3	1.5	-	2.0	2.0	2.0

PCU403	SIGNAL DETECTION AND ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of signal detection and estimation.
- To learn the basics of multi-user detection theory
- To study the concept of various estimation techniques.
- To understand Wiener filter and Kalman filter and its application in detail.
- To analyze different noise model in the channel.
- To interpret the various receiver structure under various channel conditions.

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, Cyclo stationary 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 Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

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.

TOTAL : 45 Periods

COURSE OUTCOMES:

On Completion of the course, the students will be able to

- Interpret the importance of probability and stochastic process concepts in detection and estimation.
- Design an optimum detector and estimator for AWGN channel.
- Develop and analyze the various estimators for various channel models.
- Understand the Wiener and Kalman filters to solve linear estimation problems.
- Analysis of novel receiver structures suitable for modern technology.
- Designing the noise model with good performances.

REFERENCES:

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

COURSE OUTCOMES - PROGRAM OUTCOMES ATTAINMENT MATRIX

COURSE OUTCOMES	PROGRAM OUTCOMES (POs)						PROGRAM SPECIFIC OUTCOMES(PSOs)		
	1	2	3	4	5	6	1	2	3
CO1	3	-	2	-	2	2	3	3	3
CO2	2	-	2	-	3	2	2	3	3
CO3	2	-	2	-	2	2	2	3	3
CO4	3	-	3	-	3	2	1	2	3
CO5	3	-	2	-	3	3	1	2	2
CO6	3	-	3	-	3	3	2	3	3
Average	2.7	-	2.3	-	2.7	2.3	1.8	2.7	2.8

PCU404	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To understand the basics of embedded system and ARM architecture.
2. To understand the RTOS concepts like scheduling and memory management related to the embedded system.
3. To learn about the programming aspects of RTOS.
4. To learn the different protocols of embedded wireless application.
5. To understand concepts involved in the design of hardware and software components for an embedded system.
6. To introduce basic concepts of Real time operating system and example tutorials in embedded systems for various applications.

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 Operating System Overview.

UNIT-III: CONNECTIVITY 9

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

UNIT-IV: REAL TIME UML **9**

The Rapid Object-Oriented Process for Embedded Systems (ROPES) Process. MDA and Platform Independent Models- Scheduling Model-Based Projects- Model Organization Principles- Working with Model-Based Projects - Object Orientation with UML 2.0-Structural Aspects-Object Orientation with UML 2.0-Dynamic Aspects-UML Profile for Schedulability, Performance, and Time.

UNIT-V: SOFTWARE DEVELOPMENT AND APPLICATION **9**

Concurrency – Exceptions – Tools – Debugging Techniques – Optimization – Interfacing Digital Camera with USB Port. Interfacing of Sensors and Actuators for a Real Time Industrial Application.

TOTAL : 45 Periods

COURSE OUTCOMES:

1. Ability to make a choice of suitable embedded processor for a given application.
2. Ability to design the hardware and software for the embedded system.
3. Ability to design and develop the real time kernel/operating system functions, task control block structure and analyze different task states.
4. Ability to implement different types of inter task communication and synchronization techniques.
5. Ability to understand about the aspects of embedded connectivity in real time systems.
6. Ability to illustrate and apply the concepts of real time embedded systems in real time application from multiple perspectives.

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.
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COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COs	PROGRAM OUTCOMES						PSOs		
	1	2	3	4	5	6	PSO 1	PSO 2	PSO 3
1	2	1	2	2	-	-	3	1	2
2	3	2	2	3	1	2	3	2	2
3	3	1	2	3	2	1	2	2	2
4	1	-	-	-	2	-	2	2	1
5	2	2	1	-	-	-	3	2	2
6	-	2	2	-	-	-	2	-	1
Average	2.2	1.6	1.8	2.7	1.7	1.5	2.5	1.8	1.7

CU3341 **TERM PAPER WRITING AND SEMINAR** **L T P C**
0 0 2 1

OBJECTIVES:

1. To gather information about innovative and logically developed ideas.
2. To teach students on how to refer and obtain information from a variety of sources.
3. To enable students to develop their scientific and technical reading and writing skills.
4. To direct them to use these skills to understand and construct research articles.
5. To Study the papers and understanding the author's contributions and critically analyzing each paper.
6. To help them to convert their references into logically developed ideas

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. 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	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
Stating an Objective 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 regularly in 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 – collect 20 & then filter	1. You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar 2. When picking papers to read - try to: 3. Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, 4. Favour papers from well-known journals and conferences, 5. Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), 6. Favour more recent papers, 7. Pick a recent survey of the field so you can quickly gain an overview, 8. Find relationships with respect to each other and to your topic area (classification scheme/categorization) 9. Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process 1. For each paper form a Table answering the following questions: 2. What is the main topic of the article? 3. What was/were the main issue(s) the author said they want to discuss? 4. Why did the author claim it was important? 5. How does the work build on other's work, in the author's opinion? 6. What simplifying assumptions does the author claim to be making? 7. What did the author do?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	8. How did the author claim they were going to evaluate their work and compare it to others? 9. What did the author say were the limitations of their research? 10. • 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 & 15th week	10% (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

1 Identify the Domain Specific Objective

2 Summarize the literature Survey and Analyze different Methodologies

3 Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey

4 Gather information from a variety of sources and place it in logically developed ideas

5 Develop innovative ideas and present it in paper

6 Write the Final Paper and Prepare Presentation for the research undergone

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO's	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES		
	1	2	3	4	5	6	1	2	3
CO1	3	2	2	1	-	-	2	2	2
CO2	3	2	2	2	-	-	2	2	1
CO3	3	2	3	2	-	-	2	1	1
CO4	3	2	2	1	-	-	1	1	1
CO5	3	2	2	1	-	-	1	1	1
CO6	2	2	2	1	-	-	1	1	1
Average	2.8	2.0	2.2	1.3	-	-	1.5	1.3	1.2

CU3342	PROJECT WORK – PHASE I	L	T	P	C
		0	0	12	6

OBJECTIVES:

1. Have ability to consolidate the literature search and formulate the problem for the project work.
2. Devise a solution for the problem identification.
3. Design the project to meet specification using the modern tools.
4. Construct and develop the project adhering to the norms and Professional ethics.
5. Contribute to the society as an individual or as a team.
6. Communicate effectively in Project related activities

The student individually must work on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 180 Periods

COURSE OUTCOMES:

1. Use fundamental knowledge and skills in engineering and apply it effectively on a project.
2. Plan and manage the time effectively.
3. Orally present and demonstrate a product to peers, academicians, general industry and society
4. Consider the business context and commercial positioning of designed devices or systems

5. Apply knowledge of the „real world" situations that a professional engineer can encounter
6. Function effectively as an individual to deliver an effective presentation.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	-	-	3	2	3
CO2	3	3	3	3	-	-	3	2	3
CO3	3	3	3	3	-	-	3	2	3
CO4	3	3	3	3	-	-	3	2	3
CO5	3	3	3	3	-	-	3	2	3
CO6	-	-	-	-	1	1	3	2	3
Average	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0

CU3343	INTERNSHIP	L	T	P	C
		0	0	0	1

OBJECTIVES:

1. Analyze a professional setting's strength and challenges.
2. Communicate in a workplace environment in a clear and confident manner.
3. Evaluate performance and accept feedback, in order to make changes as necessary.
4. Articulate their experience and skills to potential employers.
5. Identify and proceed next steps in their career trajectory.
6. Acquire team working skills with the community.

The students may be allowed to arrange internship. In that case a student can take a letter from the placement/respective department and contact the company. The confirmation letter from the company has to be submitted in the placement / respective department.

Students will be associated with one faculty from respective department who will act as internal mentor. During six months duration, internal mentor will assess the student's performance twice. Final Evaluation of internship will be done jointly by the internal and company mentor.

Students will maintain the record of the work done in the industry and submit a report in the institute within one week of the start of the next semester. The certificate and the report have to be duly signed by a responsible official of the company.

The institute will arrange evaluation of the internship within 15 days of the start of the semester. The date of evaluation will be notified at least one week before the date of evaluation.

COURSE OUTCOMES:

On completion of the course the student will be able to

1. Apply the knowledge, skills, and experience to a work environment.
2. Acquire new learning through challenging and meaningful activities.
3. Build and maintain strong networking/mentoring relationships.
4. Identify, clarify and/or confirm professional direction as it relates to the academic studies and future career path.
5. Develop self-understanding, self-discipline, maturity and confidence.
6. Revise and reform on critical feedbacks.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

COURSE OUTCOMES	PROGRAM OUTCOMES (POs)						PROGRAM SPECIFIC OUTCOMES(PSOs)		
	1	2	3	4	5	6	1	2	3
CO1	3	3	3	3	2	2	3	3	3
CO2	3	3	3	3	3	2	2	3	2
CO3	3	3	3	3	3	2	-	-	-
CO4	3	3	3	3	3	3	3	2	3
CO5	2	3	3	2	2	3	-	-	-
CO6	3	3	3	2	3	2	-	-	-
Average	2.8	3.0	3.0	2.7	2.7	2.3	2.7	2.7	2.7

CU3441	PROJECT WORK – PHASE II	L	T	P	C
		0	0	24	12

OBJECTIVES:

1. Have ability to consolidate the literature search and formulate the problem for the project work.
2. Devise a solution for the problem identification.
3. Design the project to meet specification using the modern tools.
4. Construct and develop the project adhering to the norms and Professional ethics.
5. Contribute to the society as an individual or as a team.
6. Communicate effectively in Project related activities

To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The student individually must work on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 180 Periods

COURSE OUTCOMES:

1. Use fundamental knowledge and skills in engineering and apply it effectively on a project.
2. Plan and manage the time effectively.
3. Orally present and demonstrate a product to peers, academicians, general industry and society

4. Consider the business context and commercial positioning of designed devices or systems
5. Apply knowledge of the „real world" situations that a professional engineer can encounter
6. Able to function effectively as an individual to deliver an effective presentation.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	3	3	3	3	-	-	3	2	3
CO2	3	3	3	3	-	-	3	2	3
CO3	3	3	3	3	-	-	3	2	3
CO4	3	3	3	3	-	-	3	2	3
CO5	3	3	3	3	-	-	3	2	3
CO6	-	-	-	-	1	1	3	2	3
Average	3.0	3.0	3.0	3.0	1.0	1.0	3.0	2.0	3.0