SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603203.

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

POST GRADUATE

CURRICULA AND SYLLABI

(Regulations 2019)

Programme: M.E. COMMUNICATION SYSTEMS

SRM VALLIAMMAI ENGINEERING COLLEGE

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

M.E. COMMUNICATION SYSTEMS

REGULATIONS – 2019

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 specialisation 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	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
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 in 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

III. 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	Program Outcomes												Program Specific Outcomes			
	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

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year I	Sem I	Applied Mathematics for Communication Engineers	3	2	2	1								1				
		Advanced Radiation Systems	3	3	3	3		2	2	2				3	3	2	2	1
		Advanced Digital Communication Techniques	3	2	2	2	2							1	3		2	1
		Advanced Digital Signal Processing	3	3	2	3		3	1	2	2	2		2	3	2	1	1
		Optical Networks	3	2	1			2	2	2				2	1		2	1
		Professional Elective I																
		Communication Systems Laboratory	3	3	3	3	3	2	3		2			3	3	3	3	3
Year I	Sem II	Advanced Wireless Communication Systems	3	3	3	1	3		2	3	2	3	2	2	2	1	1	1
		MIC and RF System Design	3	3	3	3								2	2		2	2
		Electromagnetic Interference and Compatibility	3	3	3	2								2	3		2	2
		Professional Elective II																
		Professional Elective III																
		Professional Elective IV																
		RF System Design Laboratory	2	2	2	2	3	2	2	3	3	2		2	3	3	3	3
		Term Paper Writing and Seminar	3	3	2	3	2	3	2	2	3	2	2	2		1		

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year II	Sem III	Millimeter Wave Communication	3	3	3	3									2	2	2	2
		Professional Elective V																
		Professional Elective VI																
		Project Work – Phase I	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2
Year II	Sem IV	Project Work – Phase II	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2

SRM VALLIAMMAI ENGINEERING COLLEGE

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

M.E. COMMUNICATION SYSTEMS

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI (I TO IV SEMESTERS)

SEMESTER I

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1918105	Applied Mathematics for Communication Engineers	FC	4	4	0	0	4
2.	1911101	Advanced Radiation Systems	PC	3	3	0	0	3
3.	1911102	Advanced Digital Communication Techniques	PC	3	3	0	0	3
4.	1911103	Advanced Digital Signal Processing	PC	4	3	1	0	4
5.	1911104	Optical Networks	PC	3	3	0	0	3
6.	1911xxx	Professional Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	1911110	Communication Systems Laboratory	PC	4	0	0	4	2
TOTAL				**24**	**19**	**1**	**4**	**22**

SEMESTER II

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1911201	Advanced Wireless Communication Systems	PC	3	3	0	0	3
2.	1911202	MIC and RF System Design	PC	3	3	0	0	3
3.	1911203	Electromagnetic Interference and Compatibility	PC	3	3	0	0	3
4.	1911xxx	Professional Elective II	PE	3	3	0	0	3
5.	19xxxxx	Professional Elective III	PE	3	3	0	0	3
6.	19xxxxx	Professional Elective IV	PE	3	3	0	0	3
PRACTICAL								
7.	1911219	RF System Design Laboratory	PC	4	0	0	4	2
8.	1911220	Term Paper Writing and Seminar	EEC	2	0	0	2	1
TOTAL				**24**	**18**	**0**	**6**	**21**

SEMESTER III

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1911301	Millimeter Wave Communications	PC	3	3	0	0	3
2.	19xxxxx	Professional Elective V	PE	3	3	0	0	3
3.	19xxxxx	Professional Elective VI	PE	3	3	0	0	3
PRACTICAL								
4	1911311	Project Work - Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	1911401	Project Work - Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

SUMMARY

SL No.	SUBJECT AREA	CREDIT AS PER SEMESTER				CREDITS TOTAL	%
		I	II	III	IV		
1	FC	4	-	-	-	4	5.71
2	PC	15	11	3	-	29	41.43
3	PE	3	9	6	-	18	25.72
4	EEC	-	1	6	12	19	27.14
	TOTAL	**22**	**21**	**15**	**12**	**70**	**100**

Total credits: 70

FOUNDATION COURSES (FC)

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1918105	Applied Mathematics for Communication Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911101	Advanced Radiation Systems	PC	3	3	0	0	3
2.	1911102	Advanced Digital Communication Techniques	PC	3	3	0	0	3
3.	1911103	Advanced Digital Signal Processing	PC	4	3	1	0	4
4.	1911104	Optical Networks	PC	3	3	0	0	3
5.	1911110	Communication Systems Laboratory	PC	4	0	0	4	2
6.	1911201	Advanced Wireless Communication Systems	PC	3	3	0	0	3
7.	1911202	MIC and RF System Design	PC	3	3	0	0	3
8.	1911203	Electromagnetic Interference and Compatibility	PC	3	3	0	0	3
9.	1911219	RF System Design Laboratory	PC	4	0	0	4	2
10.	1911301	Millimeter Wave Communications	PC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911220	Term Paper Writing and Seminar	EEC	2	0	0	2	1
2.	1911311	Project Work - Phase I	EEC	12	0	0	12	6
3.	1911401	Project Work - Phase II	EEC	24	0	0	24	12

PROFESSIONAL ELECTIVES (PE)
SEMESTER I
PROFESSIONAL ELECTIVE I

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911105	Advanced Satellite Communication and Navigation Systems	PE	3	3	0	0	3
2.	1911106	DSP Processor Architecture and Programming	PE	3	3	0	0	3
3.	1911107	Analog and Mixed Mode VLSI Design	PE	3	3	0	0	3
4.	1911108	Real Time Embedded Systems	PE	3	3	0	0	3
5.	1911109	MEMS and NEMS	PE	3	3	0	0	3

SEMESTER-II
PROFESSIONAL ELECTIVE II

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911204	Communication Network Modeling and Simulation	PE	3	3	0	0	3
2.	1911205	Digital Communication Receivers	PE	3	3	0	0	3
3.	1911206	Detection and Estimation Theory	PE	3	3	0	0	3
4.	1911207	VLSI for Wireless Communication	PE	3	3	0	0	3
5.	1911208	Cognitive Radio Networks	PE	3	3	0	0	3

SEMESTER-II
PROFESSIONAL ELECTIVE III

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911209	Advanced Antenna Design	PE	3	3	0	0	3
2.	1911210	Advanced Digital Image Processing	PE	3	3	0	0	3
3.	1911211	Radar Signal Processing	PE	3	3	0	0	3
4.	1911213	Advanced Wireless Networks	PE	3	3	0	0	3
5.	1912203	Internet of Things	PE	3	3	0	0	3

SEMESTER-II
PROFESSIONAL ELECTIVE IV

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911214	Wavelet Transforms and its Applications	PE	3	3	0	0	3
2.	1911215	Broadband Access Technologies	PE	3	3	0	0	3
3.	1911216	Software Defined Radio	PE	3	3	0	0	3
4.	1911217	Space Time Wireless Communication	PE	3	3	0	0	3
5.	1912209	Cloud Computing Technologies	PE	3	3	0	0	3

SEMESTER III
PROFESSIONAL ELECTIVE V

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911302	Network Routing Algorithms	PE	3	3	0	0	3
2.	1911303	Wireless Ad hoc and Sensor Networks	PE	3	3	0	0	3
3.	1911304	Multimedia Compression Techniques	PE	3	3	0	0	3
4.	1911305	Ultra Wide Band Communication	PE	3	3	0	0	3
5.	1911306	Network Processors	PE	3	3	0	0	3

SEMESTER III
PROFESSIONAL ELECTIVE VI

SL No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	1911307	Network Management	PE	3	3	0	0	3
2.	1911308	Communication Network Security	PE	3	3	0	0	3
3.	1911309	High Performance Switching Architectures	PE	3	3	0	0	3
4.	1911310	Pattern Recognition and Machine Learning	PE	3	3	0	0	3
5.	1912304	Speech Processing and Synthesis	PE	3	3	0	0	3

1918105 APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS

L T P C

4 0 0 4

OBJECTIVES:

- The primary objective of this course is to demonstrate various analytical skills in applied mathematics
- This gives extensive experience with the tactics of problem solving and logical thinking applicable in communication engineering.
- This course also will help the students to identify, formulate, abstract, and solve problems in variety of mathematical areas, including linear algebra, matrix linear programming.
- This gives Knowledge of probability and Random variables, numerical solution of ordinary differential equations.
- This course gives various mathematical skills to solve and design queuing models.

UNIT - I: LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization - Generalized eigenvectors – Canonical forms – Singular value decomposition and applications - Pseudo inverse – Least square approximations - Toeplitz matrices and some applications.

UNIT - II: LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method –- Two phase method - Transportation problems - Assignment models.

UNIT - III: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Modified Euler Method- Taylors series method to solve first order ordinary differential equations-Runge - Kutta method of fourth order for system of IVPs - Numerical stability of Runge - Kutta method - Adams - Bashforth multistep method - BVP: Finite difference method and collocation method – Point collocation-sub domain collocation method – Galerkin’s method.

UNIT - IV: PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye‟s theorem - Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation**.**

UNIT - V: QUEUEING MODELS 12

Poisson Process – Markovian queues – Single and multi - server models – Little‟s formula - Machine interference model Steady state analyses – Self service queue.

TOTAL: 60 PERIODS

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

1. Apply various methods in matrix theory to solve system of linear equations.

2. Maximizing and minimizing the functional that occur in electrical engineering discipline.

3. Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variables.

4. Could develop a fundamental understanding of linear programming models,

5. Apply the Simplex method for solving linear programming problems.

REFERENCE BOOKS:

1. Bronson, R. and Costa, G. B., “Linear Algebra”, 2nd Edition, Academic Press, 2007.
2. Burden, R. C. and Faires, J. D., "Numerical Analysis ", 9th Edition, Cengage Learning, 2016.
3. Gross, D., Shortle, J.F., Thompson, J. M. and Harris, C. M., "Fundamentals of Queueing Theory “, 4th Edition, Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‟s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. Sastry, S. S., "Introductory Methods of Numerical Analysis ", 5th Edition, PHI Learning, 2015.

6. Taha H.A., “Operations Research: An Introduction”, 9th Edition, Pearson Education Asia, New Delhi, 2016.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO3	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO4	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO5	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-

1911101	ADVANCED RADIATION SYSTEMS	L T P C
		3 0 0 3

OBJECTIVES:

The students should be made:

- To understand signal propagation at Radio frequencies, antenna radiation, and its parameters.
- To enhance student knowledge in the area of various antenna design.
- To learn about antenna arrays and modern antennas.
- To design monopole, dipole and patch antenna.
- To impart knowledge about the state of the art in antenna design technology.

UNIT – I: ANTENNA FUNDAMENTALS 9

Wave equations, radiation pattern, HPBW,FNBW, gain and directivity, polarization, equivalent circuit, radiation resistance, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Image theory; Induction, reciprocity theorem, Balance to unbalance transformer, Introduction to numerical techniques.

UNIT – II: RADIATION FROM APERTURES 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture, distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, design considerations.

UNIT – III: ARRAYS 9

Introduction-General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beamforming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self phased arrays.

UNIT – IV: MICRO STRIP ANTENNA 9

Radiation mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch and Circular patch– radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of microstrip array antenna.

UNIT – V: SPECIAL ANTENNAS AND MEASUREMENTS 9

Mobile phone antenna, base station, hand set antenna, UWB antenna, PIFA, Vivaldi antenna, Antenna for biomedical, broadband antenna, antenna factor, Gain, impedance and radiation pattern measurements, Introduction to EMC, Test sites and anechoic chamber.

TOTAL PERIODS: 45

OUTCOMES:

After studying this course, the student should be able to,

- Analyze the antenna radiation mechanism and its parameters.
- Describe the concept of aperture antennas and array antennas.
- Design various types of antenna based on application.
- Explain about the antenna measurement and test sites.
- Acquire knowledge on modern antennas.

REFERENCE BOOKS:

1. Balanis.A, “Antenna Theory Analysis and Design”, 4th Edition, John Wiley and Sons, New York, 2016.

2. Hubregt.J.Visser “Antenna Theory and Applications” 1st Edition, John Wiley & Sons Ltd, New York,2012.

3. S.Drabowitch et.al., ”Modern Antennas”, 2nd Edition Springer science business Media,Inc.2005.

4. XavierBegaud, “Ultra Wide Band Antennas”, 1st Edition, ISTE Ltd and John Wiley &Sons Ltd, New York,2013.

5. Zhijun Zhang” Antenna Design for Mobile Devices” 1st Edition, John Wiley & Sons (Asia) Ltd, New York,2011.

6. Clayton Paul, “Introduction to Electromagnetic Compatibility”, Wiley Interscience, 2006.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	2	-	-	-	-	-	-	-	3	3	2	2	1
CO2	3	3	3	3	-	-	-	-	-	-	-	3	3	2	2	1
CO3	3	3	3	-	-	-	-	-	-	-	-	3	3	2	2	1
CO4	3	2	3	2	-	2	2	2	-	-	-	3	3	2	2	1
CO5	3	3	2	3	-	-	2	2	-	-	-	2	-	-	-	2

1911102 ADVANCED DIGITAL COMMUNICATION TECHNIQUES **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- 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 apply the knowledge of Multicarrier and Multiuser Communications.

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. Carrier Synchronization -Bit 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 AND MULTIUSER COMMUNICATIONS 9

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

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Understand the basic signal-space analysis and digital transmission.
- Analyze the operation of coherent and non-coherent receivers.
- Know the basic operation of Equalizers.
- Derive the different block codes and convolutional codes.
- Apply the knowledge on Multicarrier and Multiuser Communications.

REFERENCE BOOKS:

1. M.K.Simon, S.M.Hinedi and W.C.Lindsey, “Digital communication techniques; Signal Design and Detection”, Prentice Hall of India, New Delhi, 1995.
2. Bernard Sklar, “Digital Communications”, second edition, Pearson Education, 2001.
3. John G. Proakis, “Digital Communication”, Fifth Edition, McGraw Hill Publication, 2007.
4. Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications” Artech House Publication, 2001.
5. Stephen G. Wilson, “Digital Modulation and Coding”, First Indian Reprint, Pearson Education, 2003.
6. Simon Haykin, “Digital communications”, John Wiley and sons, 1998.
7. Theodore S.Rappaport, “Wireless Communications”, 2nd edition, Pearson Education, 2010.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	1	-	-	-	-	-	-	1	3	-	2	1
CO2	3	2	3	2	3	-	-	-	-	-	-	1	3	-	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	3	-	2	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	2	1
CO5	3	-	2	2	3	-	-	-	-	-	-	2	3	-	2	1

1911103 ADVANCED DIGITAL SIGNAL PROCESSING L T P C

3 1 0 4

OBJECTIVES:

The students should be made to:

- To understand the mathematical description of random signal processing.
- To explore the general principles modelling of discrete time random signals.
- To enhance the student knowledge of conversant with important theorems and algorithms.
- To introduce the concepts of figures of merit such as power, energy, bias and consistency.
- To enable the student is familiar with estimation, prediction and filtering concepts and techniques.

UNIT-I: DISCRETE RANDOM SIGNAL PROCESSING 9+3

Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Autocorrelation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem– Finite Data records,Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

UNIT-II: SPECTRUM ESTIMATION 9+3

Bias and Consistency of estimators - Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.

UNIT-III: LINEAR ESTIMATION AND PREDICTION 9+3

Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.

UNIT-IV: ADAPTIVE FILTERS 9+3

Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT-V: STATISTICAL OPTIMIZED FILTERS 9+3

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.

TOTAL: 45+15=60 PERIODS

OUTCOMES:

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

- Formulate time domain and frequency domain description of Wide Sense Stationary process.
- Explain various noise types, filtering, LMS and RMS algorithms.
- Examine the mean, variance, auto-correlation in WSS.
- Design and develop FIR adaptive filter and polyphase filter structures.
- Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCE BOOKS:

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Prentice Hall of India, New Delhi, 2015.
2. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons Inc., New York, Indian Reprint,2018.
3. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 2002.
4. Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, Englehood Cliffs, NJ2013.
5. S. Kay,” Modern spectrum Estimation theory and application”, Prentice Hall, Englehood Cliffs, NJ2013.
6. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw-Hill, 2000.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	-	-	2	-	3	1	-	-	2	-	-	3	2	1	1
CO2	3	3	2	-	-	2	-	2	2	3	-	2	3	2	1	1
CO3	2	2	-	-	-	-	-	2	-	-	-	2	3	2	1	1
CO4	3	3	2	3	-	3	1	-	2	2	-	2	3	2	1	2
CO5	3	-	1	-	-	-	2	2	-	-	-	2	3	3	1	1

1911104 **OPTICAL NETWORKS** **L T P C**

3 0 0 3

OBJECTIVES:

The students should be made to:

- Understand the basic Optical network systems and its components such as optical amplifiers, wavelength converters.
- Explore the operations of Optical transmitter and receiver.
- Analyze the concept of optical Networking.
- Enumerate the different topologies in Optical Network.
- Examine the various Optical Network management techniques and protection schemes.

UNIT – I: INTRODUCTION TO OPTICAL NETWORKS 9

Telecommunications Networks Architecture, Services, circuit switching and packet switching, Optical Networks: Multiplexing Techniques, Second generation Optical Networks, Optical Packet Switching, Transmission Basics: Wavelength, frequencies, and channel spacing, Wavelength standards, Optical power and loss, Network Evolution, Nonlinear Effects: Self-phase Modulation, Cross-phase Modulation, Four Wave mixing, Solitons. Components: Couplers, Isolators and Circulators, Multiplexers and Filters, Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Converters.

UNIT – II: TRANSMISSION SYSTEM ENGINEERING 9

System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Crosstalk, Dispersion, Wavelength Stabilization, Overall Design Considerations. Optical Internets: Migration to IP optical networking, IP and Optical backbone, IP Routing table, MPLS and optical cross connect table, Protocol stack Alternatives, Internetworking SS7 and Legacy Transport, Internet transport network protocol stack.

UNIT – III: SONET, SDH AND OPTICAL TRANSPORT NETWORKS (OTNS) 9

SONET and SDH: SONET multiplexing hierarchy, Frame structure, Functional Component, problem detection, concatenation. Architecture of Optical Transport Networks (OTNs): Digital wrapper, in-band and out-of band control signalling, Importance of Multiplexing and multiplexing hierarchies, SONET multiplexing

hierarchies, SDH multiplexing hierarchies, New Optical Transport, OTN layered Model, Generic Framing Procedure (GFP).

UNIT – IV: WDM, NETWORK TOPOLOGIES, MPLS AND OPTICAL NETWORKS 9

WDM: WDM operation, Dense Wavelength Division Multiplexing (DWDM), Erbium-doped Fiber (EDF), WDM amplifiers, Add-Drop Multiplexers, Wavelength Continuity Property, Higher dispersion for DWDM, Tunable DWDM Lasers.

UNIT – V: NETWORK TOPOLOGIES AND PROTECTION SCHEMES 9

Robust networks, Line and path protection switching, Types of topology, Point to point topology, bi-directional line-switched ring (BLSR), meshed topology, Passive optical networks, Metro optical networks 28 MPLS and Optical Networks: IS label switching, Forwarding equivalence class (FEC), Types of MPLS nodes, Label distribution and binding, label swapping and traffic forwarding, MPLS support of Virtual Private Networks (VPN), MPLS traffic engineering, Multiprotocol Lambda switching (MPIS).

TOTAL PERIODS: 45

OUTCOMES:

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

- Describe the features of the components used in Optical communication.
- Explain the functioning of optical transmitter and receiver.
- Analyze the networking concepts in Optical.
- Categorize the networking topologies in optical communication.
- Realize the backbone of protection schemes in optical communication.

REFERENCE BOOKS:

1. Rajiv Ramaswami and Kumar Sivarajan, "Optical Networks – Practical Perspective", 3rd Edition, Morgan - Kaufmann Publishers, 2001

2. Optical Networks, Third Generation Transport Systems, Uyless Black, Pearson, 2008.

3. J.Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 3rd Edition, 2008.

4. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	-	-	-	-	-	-	-	-	-	2	1	-	1	1
CO2	3	2	1	2	-	2	2	2	-	-	-	2	1	-	1	1
CO3	3	2	1	2	-	2	2	2	-	-	-	3	1	-	2	1
CO4	3	2	1	2	-	-	-	-	-	-	-	2	1	-	2	1
CO5	3	2	-	2	-	-	-	-	-	-	-	2	1	-	2	1

1911110 COMMUNICATION SYSTEMS LABORATORY L T P C

0 0 4 2

OBJECTIVES:

The students should be made:

- To acquire knowledge on Transmission line and S- parameter estimation of microwave devices.
- To understand the basics of Microstrip Patch Antenna and its analysis.
- 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 and its adaptive filtering algorithms.

USE NETWORK ANALYSER FOR THE FOLLOWING EXPERIMENTS:

1. Measurement of transmission line parameters.
2. S-parameter estimation of Microwave devices.
3. Design and testing of a Microstrip coupler.
4. Characteristics of Microstrip patch antenna.

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

5. Generation & detection of binary digital modulation techniques.
6. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
7. Digital Filter Design.
8. Performance evaluation of simulated CDMA system.
9. Channel equalizer design (LMS, RLS).
10. Antenna Radiation Pattern measurement.

TOTAL PERIODS: 60

OUTCOMES:

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

- Measure the S-parameters for different microwave devices.
- Design the Microstrip Patch Antenna.
- Analyze the performance of various digital communication systems.
- Generate and detect digital communication signals of various modulation techniques using MATLAB.
- Observe and analyze the filtering algorithms in the communication.

LAB REQUIREMENTS:

(Requirements for a batch of 18 students)

S.No	Description of Equipment	Quantity Required
1	Vector Network Analyzer (min 1GHz)	1No.
2	Spectrum Analyzer (min 1GHz)	1 No.
3	PC with Matlab / Scilab / equivalent software (user license)	10 Nos
4	DSP Processor kit	2 Nos
5	Micro strip Device (Compatible with sourse & measuring instruments) Couplers, Antennas, Filters	1 No.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	2	-	2	3	-	3	-	-	3	2	2	2	2
CO2	3	2	3	3	3	2	2	-	2	-	-	3	3	3	3	3
CO3	3	3	3	2	3	3	3	-	2	-	-	3	3	3	3	3
CO4	3	2	2	3	3	2	3	-	2	-	-	3	3	3	3	3
CO5	3	3	3	3	3	3	3	-	2	-	-	3	3	3	3	3

1911201 ADVANCED WIRELESS COMMUNICATION SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

The students should be made:

- To understand concepts of the fundamental characteristics of wireless channels, MIMO diversity and spatial multiplexing.
- To expose the students to the importance of improving capacity of wireless channel using MIMO.
- To enable understanding of channel impairment mitigation using space-time block and Trellis codes.
- To analyse the advanced MIMO systems like layered space time codes, MU-MIMO System and MIMO-OFDM systems.
- To analyze the performance of millimeter wave communication, software defined radio and cognitive radio.

UNIT - I: FADING CHANNELS AND DIVERSITY TECHNIQUES 9

Wireless channels – Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels Error/Outage probability over fading channels, – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

UNIT - II: SPACE-TIME BLOCK AND TRELLIS CODES 9

The Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off. Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

UNIT - III: MASSIVE MIMO SYSTEM 9

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

UNIT - IV: MILLIMETER WAVE COMMUNICATION 9

Spectrum regulation, Channel propagation, Hardware technology for mmW systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

UNIT - V: SOFTWARE DEFINED RADIO AND COGNITIVE RADIO 9

SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self-controlling system, Ontology based cognitive radio.

TOTAL PERIODS: 45

OUTCOMES:

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

- Explain the basics of wireless channels and diversity techniques.
- Comprehend and appreciate the significance and role of this course in the present contemporary world.
- Apply the knowledge about the concepts of MIMO in today's communication.
- Examine the various methods for improving the data rate of wireless communication system.
- Design and Estimate the performance of software defined radio and cognitive radio techniques in information and communication technology.

TEXT BOOKS:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2005.
2. Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press 2005.

REFERENCE BOOKS:

1. Mohinder Jankiraman, Space-time codes and MIMO systems, Artech House, Boston, London. www.artech house.com, ISBN 1-58053-865-7-2004.
2. Paulraj Rohit Nabar, Dhananjay Gore, Introduction of space time wireless communication systems, Cambridge University Press, 2003.
3. MischaDohler, Jose F. Monserrat AfifOsseiran “5G Mobile and Wireless Communication Technology", Cambridge University Press, 2016.
4. Mieczyslaw M Kokar, LezekLechowicz, "Cognitive Radio Interoperability through Waveform Reconfiguration" ARTECH House 2016.
5. Sergio Verdu, “Multi User Detection” Cambridge University Press, 1998.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	-	-	-	-	-	-	-	-	-	-	1	1	1	1
CO2	3	3	-	2	-	-	2	-	2	-	-	-	1	1	3	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	2	-	1	1
CO4	3	3	3	1	3	-	2	3	-	-	2	2	2	-	1	1
CO5	3	3	2	1	2	-	2	3	2	3	-	-	2	-	1	1

1911202	MIC AND RF SYSTEM DESIGN	L T P C
		3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the fundamentals of RF design and Microwave integrated circuits.
- To analyze the various components of RF system for Wireless Communications.
- To impart knowledge on basic techniques needed for analysis of RF systems.
- To learn the concepts of active filters, oscillators and mixer circuits.
- To explore the basic ideas on MIC components and microwave power amplifier circuits.

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: IMPEDANCE MATCHING AND AMPLIFIERS 9

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in Bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match, Single ended and differential schemes.

UNIT- III: FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations , Compensation Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations

UNIT- IV: RF FILTER, OSILLATOR, MIXER 9

Overview-Basic Resonator and Filter Configuration, Special filter Realizations, Filter implementation. Basic oscillator model, High frequency oscillator configuration, Basic Characteristics of Mixers, Phase locked loops, RF directional couplers, Hybrid Couplers, Detector and Demodulator circuits.

UNIT- V: MIC COMPONENTS 9

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

TOTAL PERIODS: 45

OUTCOMES:

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

- Explain the concept of RF circuit design.
- Analyse the RF circuits to determine the performance of the circuit.
- Describe the concept of feedback systems and able to design power amplifiers.
- Assess the design of the filters, oscillators and mixers.
- Exhibit the MIC component fabrication and Microwave amplifiers.

REFERENCE BOOKS:

1. Jan Crols, Michiel Steyaert,"CMOS Wireless Transceiver Design", Kluwer Academic Publications, 1997.
2. B. Razavi, "Design of analog CMOS Integrated Circuits", McGraw Hill, 2001.
3. I.D. Robertson &S. Lucyszyn, "RFIC and MMIC Design and Technology", IEEE Circuits, Devices and Systems series 13, London, UK, 2001.
4. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
5. T. Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	2	-	-	-	-	-	-	-	2	1	-	1	1
CO2	3	3	3	3	-	-	-	-	-	-	-	2	2	-	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	1	-	1	1
CO4	3	3	3	3	-	-	-	-	-	-	-	2	2	-	2	2
CO5	3	3	3	3	-	-	-	-	-	-	-	2	2	-	2	2

1911203 ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To Study about the basics of EMI.
- To impart the knowledge on EMI coupling and control mechanisms.
- To understand the various EMI Control and Mitigation Techniques.
- To learn about various EMI Standards and Regulations.
- To examine the EMI Measurement techniques for immunity.

UNIT - I: BASIC THEORY **9**

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

UNIT - II: COUPLING MECHANISM **9**

Electromagnetic field sources and Coupling paths, Coupling via the Supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT - III: EMI MITIGATION TECHNIQUES **9**

Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding Strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT - IV: STANDARD AND REGULATION **9**

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC,

ACEC. Electro Magnetic Emission and Susceptibility Standards and Specifications, MIL461E Standards.

UNIT - V: EMI TEST METHODS AND INSTRUMENTATION 9

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Identify the various types and mechanisms of Electromagnetic Interference.
- Compare EMI test methods.
- Find the solution to EMI sources.
- Propose suitable EMI mitigation technique.
- Describe the various EMC Standards and methods to measure them.

REFERENCE BOOKS:

1. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Ed, Artech house, Norwood, 1986.
2. Daryl Gerke and William Kimmel, “EDN‟s Designer’s Guide to Electromagnetic Compatibility”, Elsevier Science & Technology Books, 2002.
3. Dr Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.
4. “Electromagnetic Compatibility by Norman Violette”, Published by Springer, 2013.
5. W Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	2	-	-	-	-	-	-	-	2	3	-	2	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2	3	-	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	-	2	2
CO4	3	3	3	2	-	-	-	-	-	-	-	2	3	-	3	3
CO5	3	3	3	2	-	-	-	-	-	-	-	2	3	-	2	2

1911219 RF SYSTEM DESIGN LABORATORY **L T P C**

0 0 4 2

OBJECTIVES:

The student should be made:

- To enable the students to verify the basic principles and design aspects involved in high frequency communication systems components.
- To analyse the different types of micro strip transmission line.
- To expose the student to different high frequency components.
- To conduct the experiments and interpret data to produce meaningful conclusion and verify with theoretical concepts.
- To design and develop RF components using micro strip technology.

LIST OF EXPERIMENTS:

(ADS/IE3D/HFSS or any similar/ equivalent tool may be used for the design)

1. Measurement of S parameters for a) Inductor b) Capacitor c) impedance Matching circuits, filters using network analyser.
2. Design of λ/2, λ/4 micro strip transmission line.
3. Design of micro strip inductor and capacitor.
4. Design of impedance matching network.
5. Design of low pass, high pass, band pass and band stop filter at RF.
6. Design and characterization of micro strip patch antennas.
7. Design and characterization of LNA.
8. Design and characterization of Mixer.
9. Design and characterization of VCO.

TOTAL PERIODS: 60

OUTCOMES:

On completion of this lab course, the student would be able to

- Apply knowledge to identify a suitable architecture and systematically design an RF system.
- Comprehensively record and report the measured data, and would be capable of analysing, interpreting the experimentally measured data and produce the meaningful conclusions.
- Design and develop micro strip filters.
- To design and develop RF components using micro strip technology.

- Able to design the circuits in ADS, E3D and HFSS for Micro strip filters and RF filter design.

LAB REQUIREMENTS:

(Requirements for a batch of 18 students)

S.No.	NAME OF THE EQUIPMENT	REQUIRED
1.	Network analyser Equipment - 1.5 GHz (Minimum)	2 Nos
2.	ADS/IE3D/HFSS or any similar / equivalent Electromagnetic Simulation tool for Design experiments - 10 User license	1 No.
3.	Desktop PC"s for hosting Electromagnetic simulation tool	10 Nos
4.	Inductor, Capacitor, matching circuits, filters capable of operating at 500 MHz or above	As required

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2	2	2	3	-	-	-	3	2	-	2	3	3	3	3
CO2	2	2	2	2	3	-	-	-	3	2	-	2	3	3	3	3
CO3	2	2	2	2	3	-	-	-	3	2	-	2	3	3	3	3
CO4	2	2	2	2	3	2	2	3	3	2	-	2	3	3	3	3
CO5	2	2	2	2	3	2	2	3	3	2	-	2	3	3	3	3

1911220 TERM PAPER WRITING AND SEMINAR **L T P C**

0 0 2 1

OBJECTIVES:

The student should be made to:

- Develop their scientific and technical reading and writing skills.
- Understand and construct research articles.
- Obtain information from a variety of sources (i.e., Journals, dictionaries, reference books).
- Write their own project base paper and can publish in journals.
- Prepare slides to present in seminars and conferences.

1. Selecting a subject, narrowing the subject into a topic.
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers).
4. Preparing a working outline.
5. Studying the papers and understanding the author's 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.

TOTAL PERIODS: 30

Activity	**Instructions**	**Submission Week**	**Evaluation**
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information	• List 1 Special Interest Groups or professional	3rd week	**3%** (the selected

about your area & topic	society • List 2 journals • List 2 conferences, symposia or workshops • List 1 thesis title • List 3 web presences (mailing lists, forums, news sites) • List 3 authors who publish regularly in your area • Attach a call for papers (CFP) from your area.		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	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people‟s survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain	4th week	**6%** (the list of standard papers and reason for selection)

	an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other‟s work, in the author‟s opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the • perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and	9th week	**6%**

	give a presentation		(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	11thweek	**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)

OUTCOMES

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

- Identify their interested topics.
- Collect the papers and journals related to their interested topics.
- Analyze the various methodologies, algorithms, techniques presented in the papers.
- Apply their knowledge and prepare their own paper with insight in interested topic.
- Prepare the slides for the presentation in seminar and conferences.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	-	-	-	-	-	3	2	1	1	-	-	-	-
CO2	3	2	1	2	1	3	1	1	3	2	1	1	-	-	-	-
CO3	3	3	3	3	3	3	3	3	3	2	3	2	-	1	-	-
CO4	2	3	3	3	3	3	3	3	3	3	3	2	-	-	-	-
CO5	2	-	-	2	-	-	-	-	3	3	-	-	-	-	-	-

1911301	MILLIMETER WAVE COMMUNICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVE:

The student should be made:

- To realize the fundamentals of Millimeter wave devices.
- To understand millimeter wave circuits.
- To evaluate the components of Millimeter wave Communications system.
- To study the types antennas and application.
- To perform the antenna design at Millimeter wave frequencies.

UNIT - I: INTRODUCTION 9

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

UNIT - II: MM WAVE DEVICES AND CIRCUITS 9

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

UNIT - III: MM WAVE COMMUNICATION SYSTEMS 9

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

UNIT - IV: MM WAVE MIMO SYSTEMS 9

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits

for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT - V: ANTENNAS FOR MM WAVE SYSTEMS 9

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

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Understand Millimeter devices and circuits.
- Design antenna for Millimeter wave frequencies.
- Analyse the Millimeter wave system.
- Develop the type of antennas.
- Implement Millimeter wave technology.

REFERENCE BOOKS:

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
3. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	-	-	-	-	-	-	-	-	1	2	-	-
CO2	3	3	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-	2	-	2	2
CO4	3	3	3	3	-	-	-	-	-	-	-	-	2	-	2	2
CO5	3	3	3	3	-	-	-	-	-	-	-	-	2	-	2	2

1911311	PROJECT WORK – PHASE I	L T P C
		0 0 12 6

OBJECTIVES:

- Have ability to consolidate the literature search and formulate the problem for the project Work.
- Devise a solution for the problem identification.
- Design the project to meet specification using the modern tools.
- Construct and develop the project (Product) adhering to the norms and Professional ethics.
- Contribute to the society as an individual or as a team.

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 PERIODS: 180

OUTCOMES:

The student should be able to:

- Use fundamental knowledge and skills in engineering and apply it effectively on a project.
- Plan and manage the time effectively.
- Orally present and demonstrate a product to peers, academicians, general industry and society.
- Consider the business context and commercial positioning of designed devices or systems
- Apply knowledge of the ‘real world’ situations that a professional engineer can encounter

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	2	3	3	-	3	-	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	-	3	3	-	-	-	-
CO3	3	3	3	3	2	-	-	-	2	3	3	3	-	-	-	-
CO4	3	3	3	3	3	-	-	-	3	-	3	3	-	-	-	2
CO5	2	1	-	3	-	-	-	-	2	3	2	1	2	2	2	2

1911401	PROJECT WORK – PHASE II	L	T	P	C
		0	0	24	12

OBJECTIVES:

- Have ability to consolidate the literature search and formulate the problem for the project Work.
- Devise a solution for the problem identification.
- Design the project to meet specification using the modern tools.
- Construct and develop the project (Product) adhering to the norms and Professional ethics
- Contribute to the society as an individual or as a team.

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 students individually must works 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 PERIODS: 360

OUTCOMES:

The student should be able to:

- Use fundamental knowledge and skills in engineering and apply it effectively on a project.
- Plan and manage the time effectively.
- Orally present and demonstrate a product to peers, academicians, general industry and society.
- Consider the business context and commercial positioning of designed devices or systems.
- Apply knowledge of the ‘real world’ situations that a professional engineer can encounter.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	2	3	3	-	3	-	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	-	3	3	-	-	-	-
CO3	3	3	3	3	2	-	-	-	2	3	3	3	-	-	-	-
CO4	3	3	3	3	3	-	-	-	3	-	3	3	-	-	-	2
CO5	2	1	-	3	-	-	-	-	2	3	2	1	2	2	2	2

1911105 ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS

L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To Learn M2M developments and satellite applications.
- To understand the Satellite Communication In IPv6 Environment.
- To know the basic principles of satellite navigation.
- To analyze the satellite services for mobile, multimedia, navigation and remote sensing applications.
- To explore the orbital mechanics, space craft sub-systems, satellite link design.

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

Overview 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

Design procedure and performance criterion-Mars exploration Rover- Mission and space craft summary-Telecommunication subsystem overview- Telecom subsystem and Link performance- Chandrayaan-1 Mission- Mangalyaan Mission, Interplanetary internet architecture- The IPN Internet architecture, The Mars communication protocol stack, Physical layer technologies, Planetary networks.

TOTAL PERIODS: 45

OUTCOMES:

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

- Discuss satellite navigation and global positioning system
- Outline deep space networks and inter planetary missions
- Understand the Satellite Communication In IPv6 Environment.
- Analyze the technical details behind the satellite link.
- Examine the satellite services for mobile, multimedia, navigation and remote sensing applications.

REFERENCE BOOKS:

1. Anil K. Maini, Varsha Agrawal, “Satellite Technology: Principles and Applications‟, Third Edition, Wiley, 2014.

2. Louis J. Ippolito, Jr. “Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance”, Second Edition, 2017.

3. Adimurthy.V,” Concept design and planning of India‟s first interplanetary mission” Current Science, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.

4. Daniel Minoli‟ “Innovations in Satellite Communication and Satellite Technology” Wiley,2015.

5. Daniel Minoli, “Satellite Systems Engineering in an IPv6 Environment”, CRC Press, First Edition, 2009.

6. Hofmann-Wellenhof B., Lichtenegger H., and ElmarWasle, “Global Navigational Satellite Systems” Springer-Verlag, 2008.

7. Jim Taylor,“ Deep Space Communications” John Wiley & Sons, 2016.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	1	1	-	-	-	-	-	-	-	2	2	-	2	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	-	2	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	2	-	2	2
CO4	3	2	2	3	-	-	-	-	-	-	-	2	2	-	2	2
CO5	3	3	1	1	-	-	-	-	-	-	-	2	2	-	2	2

1911106 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING **L T P C**

3 0 0 3

OBJECTIVES:

The objective of this course is to provide knowledge on:

- Basics on Digital Signal Processors.
- Programmable DSP‘s Architecture, On-chip Peripherals and Instruction set.
- Programming using TMS 320C5X Processor.
- Signal processing applications.
- Advanced Programmable DSP Processors.

UNIT-I: FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Introduction to Programmable DSPs, Architectural Features of PDSPs - Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals, Applications of Programmable DSPs.

UNIT-II: TMS320C5X PROCESSOR 9

Architecture of C5X Processor – Addressing modes – Assembly language Instructions - Pipeline structure, On-chip Peripherals – Block Diagram of DSP starter kit (DSK) – Software Tools, DSK on-board peripherals, Application Programs for processing real time signals.

UNIT-III: TMS320C6X PROCESSOR 9

Architecture of the C6x Processor - Instruction Set – Addressing modes, Assembler directives, On-chip peripherals, DSP Development System: DSP Starter Kit - Code Composer Studio - Support Files – Introduction to AIC23 codec and other on-board peripherals, Real-Time Programming Examples for Signals and Noise generation, Frequency analysis, Filter design.

UNIT-IV: ADSP PROCESSORS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs – Filter design, FFT calculation.

UNIT-V: ADVANCED PROCESSORS 9

Study of TI‘s advanced processors - TMS320C674x and TMS320C55x DSPs, ADSP‘s Blackfin and Sigma DSP Processors, NXP‘s DSP56Fxx Family of DSP Processors, Comparison of the features of TI, ADSP and NXP DSP family processors.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Analyze the concepts of Digital Signal Processors.
- Demonstrate their ability to program the DSP processor for signal processing applications.
- Ability to learn programing concept of TMS Processor.
- Understand the Assembler directives, On-chip peripherals, DSP Development System TMS kit.
- Discuss, compare and select the suitable Advanced DSP Processors for real-time signal processing applications.

REFERENCE BOOKS:

1. B. Venkataramani and M. Bhaskar,”Digital Signal Processors-Architecture, Programming and Applications”, Tata McGraw Hill Publishing Company Limited. New Delhi, 2017.
2. Avtar Singh and S. Srinivasan,”Digital Signal Processing-Implementations using DSP Microprocessors with Examples from TMS320C54xx”, Cengage Learning India Private Limited, Delhi 2012.
3. Rulph Chassaing and Donald Reay,”Digital Signal Processing and Applications with the C6713 and C6416 DSK”, John Wiley & Sons, Inc., Publication, 2012 (Reprint).
4. User guides Texas Instruments, “Analog Devices and NXP”. Indian Reprint - 2019.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	-	-	3	-	-	1	-	1	3	3	3	3
CO2	2	3	3	2	-	2	3	3	2	-	-	1	3	3	3	3
CO3	2	2	1	2	-	-	-	2	-	1	-	2	3	3	3	3
CO4	3	3	2	3	-	2	3	3	2	2	-	-	3	3	3	3
CO5	3	-	2	2	-	3	3	2	3	3	-	2	3	3	3	3

1911107 ANALOG AND MIXED MODE VLSI DESIGN L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To study the concepts of MOS large signal model and small signal model.
- To understand the concepts of D/A conversion methods and their architectures.
- To design filters for ADC.
- To analyze about the switched capacitor circuits.
- Explore the role of Data converters in an ever-increasing digital world.

UNIT - I: INTRODUCTION AND BASIC MOS DEVICES 9

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

UNIT - II: SUBMICRON CIRCUIT DESIGN 9

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

UNIT - III: DATA CONVERTERS 9

Static and dynamic errors in DAC and ADC – 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 PERIODS: 45

OUTCOMES:

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

- Discuss submicron circuit design.
- Compare the data converters.
- Design and analyze switched capacitor circuits.
- Analyze high-performance, stable operational amplifiers with the trade-offs between speed, precision and power dissipation.
- Identify the critical parameters that affect the analog and mixed-signal VLSI circuits performance.

REFERENCE BOOKS:

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.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Second Edition, TMH, 2016.
4. Allen Holberg, “CMOS Analog Integrated Circuit Design”, Oxford University Press, 2002.
5. P. R. Gray, Hurst, Lewis and R. G. Meyer, “Analysis and Design of Analog Integrated Circuits”, John Wiley, 4th Edition, 2001.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	-	-	-	-	-	-	-	-	2	1	-	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	2	1	-	2	-
CO3	3	3	2	2	-	-	2	2	-	-	-	2	1	-	2	-
CO4	3	3	-	2	-	-	-	-	-	-	-	2	1	-	2	2
CO5	3	2	3	2	-	-	-	-	-	-	-	2	1	-	2	2

1911108 REAL TIME EMBEDDED SYSTEMS **LT P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To study the basic concepts of ARM processors.
- To explore the computing platform and design analysis of ARM processors.
- To understand the concepts of Operating systems in ARM.
- To acquire knowledge about the behavior of embedded networks.
- To comprehend case studies related to embedded systems.

UNIT - I: INTRODUCTION TO ARM PROCEESORS 9

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT - II: COMPUTING PLATFORM AND DESIGN ANALYSIS 9

CPU buses – Memory devices – I/O devices – Memory Protection Units – Memory Management Units – Component interfacing – Design with microprocessors – Development and Debugging – Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT - III: PROCESS AND OPERATING SYSTEMS 9

Multiple tasks and multi processes – Processes – Context Switching – Scheduling policies - Multiprocessor – Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes – Firmware and Operating Systems for ARM processor.

UNIT - IV: HARDWARE ACCELERATES & NETWORKS 9

Accelerators – Accelerated system design – Distributed Embedded Architecture – Networks for Embedded Systems – Network based design – Internet enabled systems.

UNIT - V: CASE STUDY **9**

Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants – Set–Top–Box. – System-on-Silicon – FOSS Tools for embedded system development.

TOTAL PERIODS: 45

OUTCOMES:

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

- Describe the architecture and programming of ARM processor.
- Explain the basic concepts of real time Operating system design.
- Differentiate between the general-purpose operating system and the real time operating system.
- Demonstrate Multi processes, Hardware and Software co-design.
- Model real-time applications using embedded-system concepts.

REFERENCE BOOKS:

1. Andrew N Sloss, Dominic Symes and Chris Wright, “ARM system developer’s guide – Designing and Optimizing System Software”, Morgan Kaufmann publishers, 2004.
2. David E-Simon, “An Embedded Software Primer”, Pearson Education, 2007.
3. K.V.K.K.Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dreamtech press, 2005.
4. 4. Tim Wilmshurst, “An Introduction to the Design of Small Scale Embedded Systems”, Pal grave Publisher, 2004.
5. Wayne Wolf, “Computers as Components - Principles of Embedded Computer System Design”, Morgan Kaufmann Publisher, 2006.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	3	2	-	3	3	-	-	-	-	-	1	-	-	-
CO3	3	2	1	2	2	-	-	-	-	-	-	2	1	-	-	-
CO4	3	3	2	-	3	3	3	-	2	2	-	2	1	-	-	-
CO5	3	-	2	-	3	3	2	2	2	2	-	2	1	-	-	-

1911109 MEMS AND NEMS **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To learn the basic concepts and principles of MEMS and NEMS.
- To introduce the concepts of micro and nano electromechanical devices.
- To know the fabrication process of Microsystems.
- To design the concepts of micro sensors and micro actuators.
- To understand the concepts of quantum mechanics and nano systems.

UNIT – I: OVERVIEW **9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS – 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, and 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. Casestudy: 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, Combdrive 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 PERIODS: 45

OUTCOMES:

After studying this course, the student should be able to,

- Acquire knowledge about micro system design and its various applications.
- Interpret the basics of micro/nano electromechanical systems including their advantages.
- Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.
- Analyse the key performance aspects of electromechanical transducers including sensors and actuators through case studies.
- Comprehend the theoretical foundations of quantum mechanics and Nano systems.

REFERENCE BOOKS:

1. Marc Madou, “Fundamentals of Microfabrication”, CRC press 1997.
2. Stephen D. Senturia, “Micro system Design”, Kluwer Academic Publishers, 2001.
3. Tai Ran Hsu,”MEMS and Microsystems Design and Manufacture”,Tata McGraw Hill, 2002.
4. Chang Liu,”Foundations of MEMS”, Pearson education India limited, 2006.
5. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and
6. Structures”, CRC Press, 2002.
7. Mohamed Gad – el – hak, “The MEMS HAND Book”, CRC press 2005.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	2	1	-	-	-
CO3	2	3	3	2	-	-	-	-	-	-	-	2	1	-	-	-
CO4	2	3	2	2	-	-	-	-	-	-	-	2	1	-	-	-
CO5	2	2	3	2	-	-	-	-	-	-	-	2	1	-	-	-

1911204 COMMUNICATION NETWORK MODELING AND SIMULATION **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made to:

- Understand the division of network functionalities into layers.
- Familiarize with the components required to build different types of networks.
- Learn modeling and simulation.
- Interpret the wireless communication system using Monte Carlo simulation.
- Exhibit channel modeling and mobility modeling.

UNIT – I: INTRODUCTION TO MODELING AND SIMULATION 9

Introduction, Discrete-event Simulation, Modeling for Computer Simulation, Tools and Methods for Network Simulation, The Simulation Platform, Simulation Framework, Tools and Modeling Approaches for Simulating Hardware. Need for simulation.

UNIT – II: MONTE CARLO SIMULATION 9

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

UNIT – III: LOWER LAYER & LINK LAYER WIRELESS MODELING 9

Physical Layer Modeling, Description of the Main Components of the PHY Layer, Accurate Simulation of Physical Layers, Physical Layer Modelling for Network Simulations, Link Layer Modelling, Medium Access Control (MAC) Protocols, Logical Link Control, Forward Error Detection and Correction, Backward Error Detection and Correction, Queueing and Processing Delay, Queueing methods.

UNIT – IV: CHANNEL MODELING & MOBILITY MODELING 9

Channel Modelling :The Physics of Radiation, The Nature of Electromagnetic Radiation, Classification of Propagation Models, Deterministic Approaches by Classical Field Theory, Deterministic Geometric Optical Approaches, Empirical Path Loss Approaches, Stochastic Shadowing Models, Stochastic Fading Models, MIMO Channel Models. Mobility modelling :Categorization of Mobility Models, Mobility Models, Random Walk Model, Random Waypoint Model, Random Direction Model,

Gauss-Markov Model, Manhattan Model, Column Model , Pursue Model, Nomadic Community Model, Selection of Appropriate Mobility Models.

UNIT – V: HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY 9

Higher Layer Modeling: Modeling the Network Layer and Routing Protocols, Components of a Routing Protocol, Metrics, Virtual Routing on Overlays, Modeling Transport Layer Protocols, Modelling Application Traffic. Modeling the Network Topology : Abstraction of Network Topologies by Graphs, Characterizing Graphs, Common Topology Models, Geometric Random Graphs –The Waxman Model, Hierarchical Topologies, Preferential Linking –The Barabási-Albert Model , Modelling the Internet.

TOTAL PERIODS: 45

OUTCOMES:

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

- Choose the required functionality at each layer in appropriate to the application.
- Trace the flow of information from one node to another node in the network.
- Apply Monte Carlo simulation for a wireless communication link.
- Discuss Lower Layer and Link Layer Wireless Modeling.
- Compare channel modeling and mobility modelling.

REFERENCE BOOKS:

1. Irene Karzela, “Modeling and Simulating Communications Networks”, Prentice Hall India, 1998.
2. K. Wehrie. Gunes, J.Gross, “Modeling and Tools for Network simulation”,Springer 2010.
3. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, “Simulation of Communication Systems: Modeling, Methodology and Techniques”, Plenum Press, New York, 2001.
4. Nejat; Bragg, Arnold, “Recent Advances in Modeling and Simulation Tools for Communication Networks and Services”, Springer, 2007.
5. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, “Principles of Communication Systems Simulation”, Pearson Education (Singapore) Pvt. Ltd, 2004.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	2	2	3	2	-	-	-	-	-	-	2	3	-	3	3
CO2	2	2	2	2	2	-	-	-	-	-	-	2	3	-	3	3
CO3	1	2	2	2	2	-	-	-	-	-	-	2	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	-	3	3
CO5	2	3	2	3	3	-	-	-	-	-	-	2	3	-	3	3

1911205 DIGITAL COMMUNICATION RECEIVERS L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the basic principles of digital communication techniques.
- To gain knowledge about receivers for AWGN channel.
- To learn the concepts of fading channels.
- To analyze the concepts of synchronization and adaptive equalization techniques.
- To examine the various digital communication receivers, equalization and diversity techniques.

UNIT – I: REVIEW OF DIGITAL COMMUNICATION TECHNIQUES 9

Base band communication; Signal space representation, Linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

UNIT – II: OPTIMUM RECEIVERS FOR AWGN CHANNEL 9

Correlation demodulator, Matched filter, Maximum likelihood sequence detector, Optimum receiver for CPM signals, Optimum receivers for signals with random phase in AWGN channel, Envelope detection of M-ary orthogonal signals and correlated binary signals.

UNIT – III: RECEIVERS FOR FADING CHANNELS 9

Characterization of fading multiple channels, Statistical models, Flat and frequency selective fading, Diversity technique, Parameter synchronization for flat fading channels, Digital signaling over a frequency selective and slowly fading channel, Coded waveform for fading channel.

UNIT – IV: SYNCHRONIZATION TECHNIQUES 9

Carrier and signal synchronization, Carrier phase estimation-PLL, Decision directed loops, Symbol timing estimation, Maximum likelihood and non-decision directed timing estimation, Joint estimation.

UNIT – V: ADAPTIVE EQUALIZATION 9

Zero forcing algorithm, LMS algorithm, Adaptive decision-Feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, Blind equalizers and stochastic gradient algorithm.

TOTAL PERIODS: 45

OUTCOMES:

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

- Apply basic principles of digital communication techniques.
- Understand receivers for AWGN & Fading channel.
- Describe the synchronization techniques.
- Design adaptive equalization algorithms to satisfy the evolving demands in digital communication.
- Analyze the digital communication receivers, equalization and diversity techniques.

REFERENCE BOOKS:

1. John.G.Proakis, “Digital communication” 4th Edition, McGraw-Hill, New York, 2001.

2. Simon Marvin, “Digital communication over fading channel; An unified approach to performance Analysis", John Wiley, New York, 2000.

3. Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, "Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.

4. H.Meyr&G.Ascheid, “Synchronization in Digital Communications”, John Wiley, 1990.

5. R.G. Gallager, "Principles of Digital Communication", Newyork, Cambridge University Press, 2008

6.U.Mengali & A.N.D Andrea, “Synchronization Techniques for Digital Receivers”, Kluwer, 1997.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2	3	3	-	-	-	-	-	-	-	2	2	-	2	2
CO2	2	3	2	3	-	-	-	-	-	-	-	2	3	-	3	3
CO3	3	2	3	2	-	-	-	-	-	-	-	2	3	-	3	3
CO4	2	2	3	3	-	-	-	-	-	-	-	2	3	-	3	3
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	-	3	3

1911206 DETECTION AND ESTIMATION THEORY **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the basic concepts of probability, one and two dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.
- To explore the concepts of detection and estimation.
- To learn the basics of multi-user detection theory.
- To analyze the theory behind various estimation techniques.
- To assess Wiener filter and Kalman filter in detail.

UNIT – I: REVEIW OF PROBABILITY AND STOCHASTIC PROCESS 9

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

UNIT – II: SINGLE AND MULTIPLE SAMPLE DETECTION 9

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise, Performance of Binary Receivers in AWGN.

UNIT – III: FUNDAMENTALS OF ESTIMATION THEORY 9

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

UNIT – IV: WIENER AND KALMAN FILTERS 9

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, Least Squares, Kalman 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 PERIODS: 45

OUTCOMES:

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

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Examine the detection and estimation theory to solve communication problems.
- Apply probability and stochastic process concepts in detection and estimation.
- Design Wiener and Kalman filters to solve linear estimation problems.
- Analyze the Noise Models structures with good performance.

REFERENCE BOOKS:

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

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	3	-	-	-	-	-	-	-	2	2	-	2	2
CO2	2	3	2	2	-	-	-	-	-	-	-	3	3	-	3	3
CO3	2	3	2	2	-	-	-	-	-	-	-	3	2	-	2	2
CO4	3	2	3	3	-	-	-	-	-	-	-	3	2	-	2	2
CO5	3	3	2	3	-	-	-	-	-	-	-	2	2	-	2	2

1911207 VLSI FOR WIRELESS COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:

The student should be made:

- To study the design concepts of low noise amplifiers.
- To understand the types of mixers designed for wireless communication.
- To design PLL.
- To examine the VCO.
- To utilize the concepts of CDMA in wireless communication.

UNIT - I: COMPONENTS AND DEVICES 9

Integrated inductors, resistors, MOSFET and BJT AMPLIFIER DESIGN: Low Noise Amplifier Design - Wideband LNA - Design Narrowband LNA - Impedance Matching - Automatic Gain Control Amplifiers – Power Amplifiers.

UNIT - II: MIXERS 9

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion - Low Frequency Case: Analysis of Gilbert Mixer – Distortion - High-Frequency Case – Noise - A Complete Active Mixer. Switching Mixer - Distortion in Unbalanced Switching Mixer - Conversion Gain in Unbalanced Switching Mixer - Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain in Single Ended Sampling Mixer - Distortion in Single Ended Sampling Mixer - Intrinsic Noise in Single Ended Sampling Mixer - Extrinsic Noise in Single Ended Sampling Mixer.

UNIT - III: 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 - IV: SUB SYSTEMS 9

Data converters in communications, adaptive Filters, equalizers and transceivers.

UNIT - V: IMPLEMENTATIONS 9

VLSI architecture for Multitier Wireless System - Hardware Design Issues for a Next generation CDMA System.

TOTAL: 45 PERIODS

OUTCOMES:

The student should be able to:

- Design LNA.
- Develop the type of Mixers.
- Examine the types of oscillator.
- Evaluate frequency synthesizers.
- Analyze the power amplifiers.

REFERENCE BOOKS:

1. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002.
2. B.Razavi ,”RF Microelectronics” , Prentice-Hall ,2011.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 2016.
4. Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer Academic Pub., 1997.
6. Thomas H.Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press ,2003.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	**1**	**1**	**1**	**1**	6	7	8	9	10	11	12	**1**	**2**	**3**	**4**
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	-	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	-	3	3
CO3	3	2	2	2	2	-	-	-	-	-	-	2	3	-	3	3
CO4	3	2	2	2	2	-	-	-	-	-	-	2	3	-	3	3
CO5	3	2	2	2	2	-	-	-	-	-	-	2	3	-	3	3

1911208 COGNITIVE RADIO NETWORKS **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To learn the evolving software defined radio and cognitive radio techniques and their essential functionalities.
- To study the basic architecture and standards for cognitive radio.
- To understand the spectrum sensing and dynamic spectrum access protocols of cognitive radio.
- To enhance the student knowledge in advanced features of cognitive radio.
- To expose the student to evolving real time applications.

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

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, 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 DYNAMIC SPECTRUM ACCESS 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 and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

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 PERIODS: 45

OUTCOMES:

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

- Gain knowledge on the basic architecture and standards for cognitive radio.
- Apply the design principles of software defined radio and cognitive radio to develop algorithms.
- Develop the ability to implement algorithms for cognitive radio spectrum sensing and dynamic spectrum access.
- Analyse the recent advancements and protocols in cognitive radio networks.
- Explore the advanced features of cognitive radio for real world applications.

REFERENCE BOOKS:

1. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.
3. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.
4. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
5. HuseyinArslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, 2007.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	3
CO2	3	2	2	-	-	-	-	-	-	-	-	2	3	-	3	3
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	-	3	3
CO4	3	2	2	1	-	1	2	2	2	-	-	2	3	-	3	3
CO5	3	2	2	1	-	1	2	-	2	-	-	3	3	-	3	3

1**911209** **ADVANCED ANTENNA DESIGN** **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the antenna radiation characteristics and arrays.
- To enhance the student knowledge in the area of various antenna design.
- To enhance the student knowledge in the area of antenna for practical applications.
- To study the different antenna structures and become familiar with various perspectives.
- To demonstrate the antennas in various applications.

UNIT – I: ANTENNA FUNDAMENTALS AND ARRAYS 9

Review of Electromagnetic Wave equations, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Antenna parameters, linear array theory, frequency scanned arrays, phased arrays-Retro directive and self-phased arrays. Introduction to numerical techniques.

UNIT – II: MICRO STRIP ANTENNA 9

Radiation Mechanism from patch; transmission line model based analysis, cavity model, Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, Microstrip Yagi antenna, Microstrip array, Gain improvement techniques in microstrip antenna.

UNIT – III: APERTURES AND REFLECTOR ANTENNAS 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane, Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration, Design of C band and Ku band reflector antenna.

UNIT – IV: MODERN ANTENNA STRUCTURES 9

Frequency independent antenna, spiral antenna, active antenna, dielectric antenna, Leaky wave antenna, Plasma antenna, wearable antenna, reconfigurable antenna, meta material, EBG antenna, Frequency selective structures, Broad band and multi band antenna, Antenna for cellular base stations, MIMO antennas.

UNIT – V: ANTENNA FOR SPECIAL APPLICATIONS 9

Antenna for EMI/EMC testing, Antenna for EM issues in medical diagnosis and treatment, Antenna for MRI systems, Antenna for 60 GHz applications, RFID

antenna, Antenna for wireless charging systems, Antenna for automobile radar, Terahertz antennas, antenna for sensor applications.

TOTAL PERIODS: 45

OUTCOMES:

After studying this course, the student should be able to

- Understand recent design techniques in antenna.
- Ability to design and assess the performance of various antenna.
- To design the antenna for various industrial, medical and sensor applications.
- Analyze the various types of antenna and its structures.
- Interpret the different types of antennas and its applications in various fields.

REFERENCE BOOKS:

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 1982.
2. Hubregt.J.Visser, “Antenna Theory and Applications”, 1st Edition, John Wiley & Sons Ltd, Newyork, 2012.
3. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation”, Fourth Edition, Tata McGraw Hill, 2006.
4. Zhijun Zhang, “Antenna Design for Mobile Devices”, 1st Edition, John Wiley & Sons (Asia) Ltd, Newyork, 2011.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	-	-	-	-	-	-	-	2	2	-	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3	3

1911210 ADVANCED DIGITAL IMAGE PROCESSING **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the image fundamentals.
- To explore the various image segmentation techniques.
- To acquire knowledge in feature extraction in image analysis.
- To comprehend the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

UNIT – I: FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

Elements of visual perception, brightness, contrast, hue, saturation, Mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing.

UNIT – II: SEGMENTATION 9

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, and Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

UNIT – III: FEATURE EXTRACTION 9

First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model based features, Gabor filter, wavelet features.

UNIT – IV: REGISTRATION AND IMAGE FUSION 9

Registration - Pre-processing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, and wave let based fusion - region based fusion.

UNIT – V: 3D IMAGE VISUALIZATION 9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of

color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

TOTAL PERIODS: 45

OUTCOMES:

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

- Explain the fundamentals of digital image processing.
- Describe various segmentation and feature extraction techniques for image analysis.
- Analyse the techniques applied on smoothing, sharpening and enhancement.
- Exhibit the concepts of image registration and fusion.
- Explore the method of 3D image visualization.

REFERENCE BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson, Third Edition, 2010.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education, Inc., 2002.
3. Ardeshir Goshtasby, “ 2D and 3D Image registration for Medical, Remote Sensing
   and Industrial Applications”, John Wiley and Sons,2005.
4. Mark Nixon, Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press, 2008.
5. Rick S.Blum, Zheng Liu, “Multisensor image fusion and its Applications”, Taylor& Francis, 2006.
6. Rick S.Blum, Zheng Liu, “Multisensor image fusion and its Applications”, Taylor& Francis, 2006.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	3	-	-	-	-	-	-	-	2	1	-	-	-
CO2	3	3	1	3	-	-	-	-	-	-	-	2	1	-	-	-
CO3	2	2	1	2	-	-	-	-	-	-	-	2	1	-	-	-
CO4	3	3	1	2	-	-	-	-	-	-	-	2	1	-	-	-
CO5	3	3	2	3	-	-	-	-	-	-	-	2	1	-	-	-

1**911211** **RADAR SIGNAL PROCESSING** **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the basic concepts of Radar systems and signal processing.
- To study the various signal models and frequency models.
- To illustrate the concepts of Sampling and Quantization of pulsed radar signals.
- To gain in-depth knowledge in Radar waveforms and its filters.
- To describe the Doppler processing, MTI platforms and applications of radar signal processing.

UNIT – I: INTRODUCTION TO RADAR SYSTEMS 9

Basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing, Radar Literature.

UNIT – II: SIGNAL MODELS 9

Components of a radar signal, Criteria for Sampling Radar Signals, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the Doppler shift, spatial models, spectral model.

UNIT – III: SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

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

UNIT – IV: RADAR WAVEFORMS 9

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

UNIT – V: DOPPLER PROCESSING 9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse

Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing, Applications of Radar Signal Processing.

TOTAL PERIODS: 45

OUTCOMES: After studying this course, the student should be able to

- Explain the basic principles of radar function and its elements involved in radar systems.
- Interpret the components of radar signal and its models.
- Express the sampling and quantization of pulsed radar signals.
- Describe the types of radar waveforms.
- Discuss on Doppler processing and its issues.

REFERENCE BOOKS:

1. Francois Le Chevalier, "Principles of Radar and Sonar Signal Processing", 2002 Artech House, Inc.
2. Fred E. Nathanson, “Radar Design Principles: Signal Processing and the Environment”, 2nd Edition, 1999, PHI.
3. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, New York, 2005.
4. Michael O Kolawole, “Radar systems, Peak Detection and Tracking”, 2010, Elseveir.
5. Peyton Z. Peebles, "Radar Principles", 2009 Wiley India.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3	3
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	3	3
CO3	3	3	-	3	-	-	-	-	-	-	-	-	3	-	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3	3

1911213	ADVANCED WIRELESS NETWORKS	L T P C
		3 0 0 3

OBJECTIVES:

The student should be made:

- To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE-A.
- To understand the wireless IP architecture, Packet Data Protocol and LTE network architecture.
- To acquire knowledge about adaptive link layer, hybrid ARQ and graphs routing protocol.
- To explore the mobility management, cellular network, and micro cellular networks.
- To analyze the Quality of service concepts in wireless IP Networks.

UNIT - I: INTRODUCTION 9

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

UNIT - II: 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 - III: ADAPTIVE LINK AND NETWORK LAYER 9

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

UNIT - IV: MOBILITY MANAGEMENT 9

Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution-Mobility Prediction in Pico- and Micro-Cellular Networks.

UNIT - V: QUALITY OF SERVICE 9

QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearers and QoS in LTE networks.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Explain the latest 4G networks and LTE.
- Describe the wireless IP architecture and LTE network architecture.
- Examine the adaptive link layer and network layer graphs and protocol.
- Comprehend the mobility management and cellular network.
- Explore the wireless sensor network architecture and its concept.

REFERENCE BOOKS:

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

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	1	-	-	2	2	-	-	-	2	3	-	3	3
CO2	3	2	2	1	-	-	2	2	-	-	-	2	3	-	3	3
CO3	3	2	2	1	-	-	2	-	-	-	-	2	3	-	3	3
CO4	3	2	2	1	-	-	2	2	-	-	-	2	3	-	3	3
CO5	3	2	2	1	-	-	2	-	-	-	-	2	3	-	3	3

1912203 INTERNET OF THINGS L T P C

3 0 0 3

OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To understand the challenges in IOT and IOT applications
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT - I: INTRODUCTION TO IoT 9

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models- Machine to Machine, Difference between IoT and M2M, Software define Network.

UNIT - II: CHALLENGES AND DOMAIN SPECIFIC APPLICATIONS IN IoT 9

Design challenges, Development challenges, Security challenges, Other challenges- Home automation, Industry applications, Surveillance applications.

UNIT - III: IoT Protocols 9

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – CoAP – Security.

UNIT - IV: BUILDING IOT PRODUCTS 9

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces.

UNIT - V: DEVELOPING IOT PROGRAMS 9

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Analyze the various fundamentals for IoT.

- Develop solution for challenges in IoT devices and applications.
- Analyze the basics of IOT protocols.
- Design a portable IoT using Raspberry Pi.
- Analyze applications of IoT in real time scenario.

REFERENCES:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”, Universities Press, 2015.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.
3. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012.
5. Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	-	3	3	-	-	-	-	3	-	-	-	-	-	1
CO2	3	3	-	-	3	-	-	-	-	3	-	-	-	-	-	1
CO3	3	3	-	-	3	-	-	-	-	3	-	-	-	-	-	1
CO4	3	3	-	-	3	-	-	-	-	3	-	-	-	-	-	1
CO5	3	3	-	3	3	-	-	-	-	3	-	-	-	-	-	1

1911214 WAVELET TRANSFORMS AND ITS APPLICATIONS L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the fundamentals concepts of wavelet transforms.
- To examine the system design using Wavelets.
- To analyze the different wavelet families.
- To explore discrete wavelet transforms.
- To realize the various applications of Wavelet families.

UNIT - I: INTRODUCTION TO WAVELETS 9

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

UNIT - II: MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM 9

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter 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: WAVELET APPLICATIONS 9

Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids

TOTAL PERIODS: 45

OUTCOMES:

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

- Comprehend the knowledge on Wavelet transforms.
- Apply the concept of wavelet in Multi rate Signal Processing.
- Analyse the performance of discrete wavelet transforms.
- Compare the properties of various Wavelet families.
- Design a Wavelet system for applications in various fields.

REFERENCE BOOKS:

1. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, "Introduction to wavelets and wavelet transform", Prentice Hall, 1998.
2. Metin Akay, "Time frequency and wavelets in biomedical signal processing", Wiley-IEEE Press, October 1997.
3. M.Vetterli and J. Kovacevic, "Wavelets and sub band coding", Prentice Hall, 1995.
4. Raguveer m Rao & Ajith S. Bopardikar, "Wavelet transforms – Introduction to theory and applications", Addison Wesley, 1998.
5. S.Mallet, "A Wavelet tour of Signal Processing", Academic Press 1998.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	2	-	-	-	-	-	-	-	-	2	3	-	3	1
CO2	3	3	2	2	-	-	-	-	-	-	-	-	3	-	3	1
CO3	3	1	2	3	-	-	-	-	-	-	-	-	3	-	3	1
CO4	3	1	2	-	-	-	-	3	-	-	-	2	3	-	3	1
CO5	3	3	3	2	-	-	-	-	-	-	-	3	3	-	3	1

1**911215** **BROADBAND ACCESS TECHNOLOGIES** **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the fundamental concepts related to broadband access technologies.
- To examine the current and emerging wired and wireless access technologies.
- To acquire knowledge about cable modems.
- To analyze the fiber access technologies.
- To have an exposure to different systems standards for next generation broadband access networks.

UNIT - I: REVIEW OF ACCESS TECHNOLOGIES 9

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT -II: DIGITAL SUBSCRIBER LINES 9

Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.

UNIT - III: CABLE MODEM 9

Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

UNIT - IV: FIBER ACCESS TECHNOLOGIES 9

Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison, Broadband PON, Gigabit-Capable PON.

UNIT - V: BROAD BAND WIRELESS 9

Fixed Wireless, Direct Broadcast Satellite (DBS), Multi-channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and

Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000, Introduction to LTE-A.

TOTAL PERIODS: 45

OUTCOMES:

On completion of course the student should be able to:

- Identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system.
- Illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL.
- Summarize the versions of cable network standard and MAC protocols for HFC networks.
- Distinguish the cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks.
- Outline the types of broadband wireless access technologies and their characteristics.

REFERENCE BOOKS:

1. Dennis J. Rauschmayer, “ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines”, Macmillan Technology Series, 1998.
2. Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and Cable Modems”, John Wiley & Sons, 2000.
3. Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, “Broadband Optical Access Networks”, John Wiley and Sons, New Jersey, 2011.
4. Martin P. Clarke, “Wireless Access Network: Fixed Wireless Access and WLL Network Design and Operation”, John Wiley & Sons 2000.
5. Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999.
6. Sassan Ahmadi, “LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies”, Elsevier, 2014.

7. Walter J Woralski, “ADSL and DSL Technologies”, McGraw Hill Computer Communication Series, Second Edition Oct 2001.
8. William Webb, “Introduction to Wireless Local Loop Broadband and Narrow Band System”, Mobile Communication Series, Artech House Publishers, Second Edition 2000.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	2	2	1	-	-	2	2	-	-	-	2	3	-	3	1
CO2	3	2	2	1	-	-	1	2	-	-	-	2	3	-	3	1
CO3	3	2	2	1	-	-	1	2	-	-	-	2	3	-	3	1
CO4	3	2	2	1	-	2	1	2	-	-	-	2	3	-	3	1
CO5	3	2	2	1	-	2	1	2	-	-	-	2	3	-	3	1

1911216 SOFTWARE DEFINED RADIO **L T P C**

3 0 0 3

OBJECTIVES:

The students should be made to:

- Understand the basics of software defined radio.
- Explore the radio frequency implementation.
- Analyse the multi rate signal processing and digital generation of signals.
- Recognise an ADC and DAC technology and smart antennas.
- Acquire Knowledge of digital hardware architectures.

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, SDR-3000.

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: DATA CONVERTERS AND SMART ANTENNAS 9

Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas-Hardware implementation of Smart Antennas.

UNIT - V: DIGITAL HARDWARE AND SOFTWARE CHOICES 9

DSP Processors, FPGA, ASIC s. Trade-offs, object oriented programming, Object Brokers, GNU Radio-USRP.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course the students should be able to:

- Frame system-level decisions for software defined radio technology and products.
- Design of analog RF components as front end block in implementation of SDR.
- Analyze the different multirate signaling technique for frequency conversion and sampling issues.
- Implement smart antenna algorithms and ADC and DAC technology.
- Interpret the digital hardware architectures and the associated programming tools.

REFERENCE BOOKS:

1. Jeffrey H.Reed, "Software Radio: A Modern Approach to Radio Engineering", Prentice Hall, 2002.

2. Joseph Mitola, "Software Radio Architecture: Object Oriented Approaches to Wireless System Engineering", Wiley-Inter science, I Edition 2000, ISBN: 0471384925.

3. Radio, G. N. U. "The gnu software radio" Available from World Wide Web: https://gnuradio. org (2007).

4. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, "Cognitive Radio-An Enabler for Internet of things", River Publishers, 2017.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	2	-	2	2	2	-	-	-	2	2	-	1	2
CO2	3	2	2	2	-	-	-	-	-	-	-	2	2	-	1	2
CO3	3	2	2	2	-	-	-	-	-	-	-	2	2	-	1	2
CO4	3	2	3	2	-	-	2	-	-	-	-	2	2	-	1	2
CO5	3	2	3	2	3	2	2	2	-	-	-	2	2	2	1	2

1911217 SPACE TIME WIRELESS COMMUNICATION **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To realize the concept of multiple antenna propagation.
- To understand the concept of capacity of frequency flat deterministic MIMO channel.
- To comprehend the concept of transmitter and receiver diversity technique.
- To design the coding for frequency flat channel.
- To analyze the concept of micro multi user detection.

UNIT - I: MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION 9

Wireless channel – Scattering model in macrocells – Channel as a ST random field – Scattering functions, Polarization and field diverse channels – Antenna array topology – Degenerate channels – reciprocity and its implications – Channel definitions – Physical scattering model – Extended channel model – Channel measurements – sampled signal model – ST multiuser and ST interference channels – ST channel estimation.

UNIT - II: CAPACITY OF MULTIPLE ANTENNA CHANNELS 9

Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter – Channel known to the transmitter – capacity of random MIMO channels – Influence of ricean fading – Ergodic and Outage Capacity – Capacity of frequency selective MIMO channels.

UNIT - III: SPATIAL DIVERSITY 9

Diversity gain – Receive antenna diversity – Transmit antenna diversity – Diversity order and channel variability – Diversity performance in extended channels – Combined space and path diversity – Indirect transmit diversity – Diversity of a space-time – frequency selective fading channel-Spatial Multiplexing.

UNIT - IV: MULTIPLE ANTENNA CODING AND RECEIVERS 9

Coding and interleaving architecture – ST coding for frequency flat channels – ST coding for frequency selective channels – Receivers–SISO–SIMO–MIMO–Iterative MIMO receivers – Exploiting channel knowledge at the transmitter: linear pre-filtering

– optimal pre-filtering for maximum rate – optimal pre-filtering for error rate minimization.

UNIT - V: SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION 9

SISO-OFDM modulation, MIMO-OFDM modulation – Signaling and receivers for MIMO– OFDM – SISO–SS modulation – MIMO-SS modulation – Signaling and receivers for MIMO - Outage performance for MIMO-MU.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Examine the channel characterization.
- Analyze the capacity of random MIMO channel.
- Design and analyze the order diversity and channel variability.
- Evaluate the multiple antenna coding and receivers.
- Asses the MIMO multi user detection.

REFERENCE BOOKS:

1. Sergio Verdu, “Multi User Detection” , Cambridge University Press, 2011.
2. A. Paulraj, Rohit Nabar, Dhananjay Gore, “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2008.
3. Don Tarrieri, “Principles of Spread Spectrum Communication systems”, Springer, Third edition, 2015.
4. Theodore S.Rappaport., ‘Wireless Communications’, 2nd Edition, Pearson Education, 2002.
5. Yong Soo Cho, ‘MIMO – OFDM wireless communications with MATLAB’, IEEE press, John Wiley publications, 2010.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	3	3	-	3	2	2	-	-	2	3	3	-	3	3
CO2	2	2	3	3	-	2	2	2	-	-	2	2	3	-	3	3
CO3	2	2	2	1	-	2	2	2	-	-	2	3	3	-	3	3
CO4	2	1	3	3	-	2	2	2	-	-	2	3	3	-	3	3
CO5	3	3	2	3	-	3	2	2	-	-	3	2	3	-	3	3

1912209 CLOUD COMPUTING TECHNOLOGIES L T P C

3 0 0 3

OBJECTIVES:

- To learn about the concept of cloud computing.
- To have knowledge on the virtualization in cloud computing.
- To be familiar with cloud architecture, services and storage.
- To appreciate the resource management and security in cloud environment.
- To familiarize with AWS and open nebula.

UNIT - I: INTRODUCTION TO CLOUD COMPUTING 9

Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.

UNIT - II: VIRTUALIZATION 9

Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation.

UNIT - III: CLOUD ARCHITECTURE, SERVICES AND STORAGE 9

NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS –SaaS – Architectural Design Challenges – Cloud Storage.

UNIT - IV: RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9

Inter Cloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Software-as-a-Service Security-Data Security –Application Security – Virtual Machine Security.

UNIT - V: CASE STUDIES 9

Google App Engine(GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services(AWS) – GAE Applications – Cloud Software Environments – Eucalyptus – Open Nebula –Open Stack.

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course, the students should be able to:

- Understand the main concepts, key technologies, strengths and limitations of cloud computing.

- Learn the key and enabling virtualization technologies that help in the development of cloud.
- Develop the ability to understand and use of cloud architecture services and storage.
- Explain the core issues in resource management and security of cloud.
- Be able to install and use current cloud technologies AWS open nebula.

REFERENCE BOOKS:

1. Buyya R., Broberg J., Goscinski A., “Cloud Computing: Principles and Paradigm”, First Edition, John Wiley & Sons, 2011.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. Ritting house, John W., and James F. Ransome, “Cloud Computing: Implementation, Management, And Security”, CRC Press, 2017.
4. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata Mcgraw Hill, 2013.
5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach”, Tata Mcgraw Hill, 2009.
6. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)”, O'Reilly, 2009.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	-	-	2	-	-	2	-	-	-	-	-	1	-	1	1
CO2	-	3	3	-	-	-	-	3	-	-	-	-	1	-	1	1
CO3	2	-	3	-	-	-	2	-	-	-	-	-	2	-	3	3
CO4	-	-	-	2	-	2	-	-	-	-	-	-	3	2	3	3
CO5	-	3	-	2	-	-	-	3	-	-	-	-	3	2	3	3

1911302 NETWORK ROUTING ALGORITHMS **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To expose to the layered architecture for communication networks and the specific functionality of the network layer.
- To understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network.
- To analyse different routing algorithms existing and their performance characteristics**.**
- To familiarize with the mobile – IP protocols and make them understand the wireless communication networks.
- To explore the architecture of the mobile ad hoc networks and various routing algorithms involved in it for designing an ad hoc network.

UNIT - I: INTRODUCTION **9**

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Nonhierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT - II: INTERNET ROUTING **9**

Interior protocol: Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT - III: ROUTING IN OPTICAL WDM NETWORKS **9**

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements,

Wavelength Rerouting- Benefits and Issues, Light path Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT - IV: MOBILE - IP NETWORKS 9

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based: Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

UNIT - V: MOBILE AD –HOC NETWORKS 9

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing:Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP)

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Select an appropriate routing algorithm for a given application.
- Implement the algorithm and analyze its performance.
- Design a new algorithm suitable to the needs.
- Analyze the mobile – IP networks.
- Apply the knowledge to create an ad hoc network.

REFERENCE BOOKS:

1. A.T Campbell et al.,Comparison of IP Micromobility Protocols, IEEE Wireless Communications Feb.2002, pp 72-82.
2. C.E Perkins, “Ad Hoc Networking”, Addison – Wesley, 2001.
3. C.Siva Rama Murthy and Mohan Gurusamy, “WDM Optical Networks – Concepts, Design and Algorithms”, Prentice Hall of India Pvt. Ltd, New Delhi –2002.
4. Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, “A Survey of mobility Management in Next generation All IP- Based Wireless Systems”, IEEE Wireless Communications Aug.2004, pp 16-27.
5. M. Steen Strub, “Routing in Communication network”, Prentice Hall International, Newyork, 1995.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	2	-	-	-	-	-	-	-	2	1	-	1	1
CO2	3	2	1	2	-	-	-	-	-	-	-	2	3	-	3	3
CO3	3	2	1	2	-	-	-	-	-	-	-	2	3	-	3	3
CO4	3	2	1	2	-	-	-	-	-	-	-	2	3	-	3	3
CO5	3	2	1	2	-	-	-	-	-	-	-	1	3	-	3	3

1911303 WIRELESS AD HOC AND SENSOR NETWORKS L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To study the fundamentals of Ad hoc network and Sensor Network.
- To learn various fundamental and emerging protocols of all layers.
- To analyze about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and Sensor networks.
- To gain complete knowledge about the nature and applications of Ad-hoc and Sensor networks.
- To have an exposure to the applications of Sensor network and also to programming tools.

UNIT - I: MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT -II: ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

UNIT - III: MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS 9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT - IV: SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT - V: SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Ad hoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

TOTAL PERIODS: 45

OUTCOMES:

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

- Describe the basics of Ad hoc networks and Wireless Sensor Networks.
- Analyse protocols developed for ad-hoc and sensor networks.
- Apply the knowledge to identify appropriate physical and MAC layer protocols.
- Identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for societal applications and become familiar with the tools used in Wireless Sensor Networks.

REFERENCE BOOKS:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications”, 2nd Edition, World Scientific Publishing, 2011.
3. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.
4. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
5. Erdal Çayırcı, Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	-	-	1	-	1	-	-	-	-	-	-	3	-	3	3
CO2	3	2	1	1	-	-	-	-	2	-	-	2	3	-	3	3
CO3	3	2	-	-	-	-	2	2	-	-	-	-	3	-	3	3
CO4	3	2	1	1	-	1	2	2	2	-	-	2	3	-	3	3
CO5	3	2	1	-	3	-	2	2	-	-	-	2	3	1	3	3

1911304 MULTIMEDIA COMPRESSION TECHNIQUES L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- 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 comprehend the use of compression in multimedia processing applications.
- To implement compression standards in detail.

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

OUTCOMES:

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

- 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.

REFERENCE BOOKS:

1. David Solomon, “Handbook of Data Compression”, Fifth Edition, Springer Verlag, New York, 2010.
2. Darrel Hankerson, Greg A Harris, Peter D Johnson, “Introduction to Information Theory and Data Compression”, Second Edition, Chapman and Hall, CRC press, 2003.
3. Khalid Sayood, “Introduction to Data Compression”, Morgan Kauffman Harcourt India, Third Edition, 2010.
4. Mark S. Drew, Ze-Nian Li, “Fundamentals of Multimedia”, PHI, 2009.
5. Peter Symes, “Digital Video Compression”, McGraw Hill Pub., 2004.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	3	1	-	-	3	-	-	-	-	-	2	-	-	-	1
CO2	2	2	2	-	-	3	-	-	-	-	-	2	-	-	-	1
CO3	2	2	1	-	-	3	-	2	-	-	-	2	-	-	-	1
CO4	1	2	1	2	-	2	2	2	-	-	-	2	-	-	-	1
CO5	2	2	2	2	-	-	2	2	-	-	-	2	-	-	-	1

1911305 ULTRA WIDEBAND COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

The student should be made to:

- Understand the fundamental concepts related to Ultra wide band communication.
- Estimate the channel model and 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 PERIODS: 45

OUTCOMES:

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

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

REFERNCE BOOKS:

1. Homayoun Nikookar and Ramjee Prasad, “Introduction to Ultra Wideband for Wireless Communications”1st Edition, Springer Science & Business Media B.V. 2010.
2. Thomas Kaiser, Feng Zheng, “Ultra Wideband Systems with MIMO”, 1st Edition, John Wiley & Sons Ltd, New York, 2010.
3. W. Pam Siriwongpairat and K. J. Ray Liu, “Ultra-Wideband Communications Systems: Multiband OFDM approach” John Wiley and IEEE press, New York 2008.
4. 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" – CRC Press; 1 edition, 2019.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	-	-	-	2	-	-	-	-	2	3	2	3	3
CO2	3	3	2	-	-	-	2	-	-	-	-	2	3	2	3	3
CO3	3	2	3	3	-	-	2	2	-	-	-	2	3	2	3	3
CO4	3	2	3	-	-	2	2	2	-	-	-	2	3	2	3	3
CO5	3	2	3	3	-	2	2	2	-	-	-	2	3	2	3	3

1911306 NETWORK PROCESSORS **L T P C**

3 0 0 3

OBJECTIVES:

The students should be made to:

- Understand the operation of network processors.
- Realize commercial network processors.
- Learn about commercial network processors.
- Comprehend the network processor architecture.
- Analyse the Network Processor IOS Technologies.

UNIT-I: INTRODUCTION **9**

Traditional protocol processing Systems – Network processing Hardware – Basic Packet Processing Algorithms and data Structures - Packet processing functions – Protocol Software – Hardware Architectures for Protocol processing – Classification and Forwarding – Switching Fabrics.

.**UNIT-II: NETWORK PROCESSOR TECHNOLOGY** **9**

Network Processors: Motivation and purpose - Complexity of Network Processor Design – Network Processor Architectures architectural variety, architectural characteristics Peripheral Chips supporting Network Processors: Storage processors, Classification Processors, Search Engines, Switch Fabrics, Traffic Managers.

UNIT-III: COMMERCIAL NETWORK PROCESSORS **9**

Multi-Chip Pipeline, Augmented RISC processor, Embedded Processor plus Coprocessors, Pipelilne of Flomogeneous processors. Configurable Instruction set processors – Pipeline of Electrogeneous processors – Extensive and Diverse processors – Flexible RISC plus Coprocessors – Scalability issues – Design Tradeoffs and consequences.

UNIT-IV: NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING **9**

Architecture: Intel Network Processor: Multi headed Architecture Overview – Features- Embedded EISC processor - Packet Processor Hardware – Memory interfaces – System and Control Interface Components – Bus Interface.

Programming Software Development Kit-IXP Instruction set – register formats – Micro Engine Programming – Intra thread and Inter-thread communication– thread synchronization – developing sample applications – control plane – ARM programming.

UNIT-V: IOS TECHNOLOGIES 9

CISCO COS – Connectivity and scalability – high availability – IP routing – IP services – IPV6 –Mobile IP – MPLS – IP Multicast 0 Manageability – QoS – Security – Switching – Layer VPN2.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students should be able to:

- Understand the Network Processor Technology.
- Analyze the commercial Network Processors.
- Explain the programming concepts of Network Processor.
- Apply the knowledge of advanced features of EISC processor, IP routing, QoS and Security.
- Explore the IOS Technologies.

REFERENCE BOOKS:

1. Douglas E.Comer “Networks Systems Design using Network Processors” Prentice Hall JaN. 2017.
2. Erik, J.Johnson and Aaron R.Kunze, “IXP2400/2806 Programming: The Microengine Coding Grade” Intel Press.
3. Hill Carlson, “Intel Internet Exchange Architecture & Applications a Practical Guide to Intel‟s network Processors” Intel press. www.cisco.com.
4. Panas C. Lekkas, “Network Processors: Architectgures, Protocols and Paradigms Telecom Engineering)”, McGraw Hill, Professional, 2014.
5. Patrick Crowley, M Eranklin, H. Hadminglu, PZ Onfryk, “Network Processor Design, Issues and Practices Vol-1” Morgan Kaufman, 2016.
6. Patrick Crowley, M a Frankliln, H. Hadimioglyum PZ Onufryk, Network Processor Design, Issues and Prentices vol-I, Morgan Kaufman, 2014.
7. Ran Giladi, Network Processors: Architecture, Programming, and Implementation, Morgan Kauffmann, 2015.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	-	3	3	-	-	1	-	1	1	-	1	1
CO2	2	3	2	2	-	3	3	3	2	-	-	1	2	-	2	2
CO3	3	2	1	3	-	3	-	2	-	1	-	2	2	2	2	2
CO4	3	3	2	3	-	2	3	3	2	2	-	2	2	-	2	2
CO5	3	-	2	2	-	-	3	2	-	3	-	2	2	-	2	2

1911307 NETWORK MANAGEMENT **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To introduce the OSI network management.
- To review broad band network management like ATM, LAN.
- To familiarize concepts and terminology associated with SNMP.
- To be aware of current trends in network management technologies.
- To describe about the web based management schemes.

UNIT - I: OSI NETWORK MANAGEMENT 9

OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS.

UNIT - II: BROADBAND NETWORK MANAGEMENT 9

Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network reference model, Integrated local Management Interface. ATM Management Information base, Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital Exchange Interface Management.

UNIT - III: SIMPLE NETWORK MANAGEMENT PROTOCOL 9

SNMPv1 Network Management: Communication and Functional Models. The SNMP Communication Model, Functional model. SNMP Management SNMPv2: Major Changes in SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base,SNMPv2 Protocol, Compatibility With SNMPv1.Configuration management, Fault management, Performance management, Event Correlation Techniques 168 security management, Accounting management, Report Management, Policy Based Management, Services Level Management.

UNIT - IV: NETWORK MANAGEMENT SYSTEMS 9

Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Commercial Network management Systems, System Management and Enterprise Management Solutions.

UNIT - V: WEB – BASED MANAGEMENT 9

NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- To diagnose problems and make minor repairs to computer networks using appropriate diagnostics software.
- To demonstrate how to correctly maintain LAN computer systems.
- To maintain the network by performing routine maintenance tasks.
- To apply network management tools.
- To describe the web based management scheme.

REFERENCE BOOKS:

1. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi, 1999.
2. Mani Subramanian, "Network Management - Principles and Practice", Pearson Education, Second edition, 2010.
3. Mark Burges, "Principles of Network System Administration", Wiley, 2000 “Applied Cryptography”, John Wiley & Sons, 1994.
4. Salah Aiidarons and Thomas Plevayk, "Telecommunications Network Technologies and Implementations”, Eastern Economy Edition IEEE press, New Delhi, 1998
5. Stephen Morris, "Network Management, MIBs and MPLS - Principles, Design and Implementation", Pearson Education, 2003.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	-	1	-	-	-	-	-	-	-	-	-	2	2	-	2	2
CO2	-	-	2	-	-	-	-	1	2	-	-	-	2	-	2	2
CO3	1	-	-	2	-	-	-	1	-	-	-	-	2	-	2	2
CO4	1	-	1	2	-	-	-	-	-	-	-	-	2	-	2	2
CO5	-	-	1	-	-	-	-	-	2	-	-	2	2	-	2	2

1911308 COMMUNICATION NETWORK SECURITY **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To introduce the number theory and its application in cryptography.
- To review symmetric and asymmetric cryptosystems.
- To describe authentication and digital signature.
- To learn Authentication protocols.
- To find out the security at network layers.

UNIT - I: INTRODUCTION AND NUMBER THEORY **9**

Introduction to Information Security, Computer Security & Network Security. Need For Security. Security – Goals, Attacks, Security Services and Mechanisms, and Techniques. Number Theory and Mathematics for Symmetric Cryptography- Finite Arithmetic, Congruence Arithmetic-Linear Congruence and Quadratic Congruence. Mathematics for Asymmetric-Key Cryptography: Fermat's Theorem and Euler's Theorem, Primes, Primality Testing, Factorization, CRT, Exponentiation. Classical Symmetric-Key Ciphers –Substitution Ciphers, Transposition Ciphers.

UNIT - II: SYMMETRIC AND ASYMMETRIC CRYPTOSYSTEMS **9**

Modern Symmetric-Key Cipher - Block Ciphers (DES, 3DES, AES and its mode of operations), Stream Ciphers, Asymmetric-Key Cryptosystem- RSA, ElGamal, ECC, Key Management - Diffie-Hellman (DH) Mechanism, Kerberos – Needham Schroeder Protocol.

UNIT - III: AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES **9**

Message Integrity & Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution – RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management .

UNIT - IV: TRUSTED IDENTITY 9

Entity Authentication: Password System- Fixed and One time Passwords (S/Key) RFC 2289 – Callback Systems, Zero Knowledge, Challenge and Response Systems – RADIUS —- ITU-T X.509.

UNIT - V: SECURITY AT LAYERS 9

Network Layer Security - IPSec, Transport Layer Security- SSL/TLS, SSH, Application Layer Security –PGP, S/MIME, Firewall - Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- To describe the techniques involved in number theory.
- To classify the symmetric and asymmetric cryptosystems.
- To evaluate the Message Authentication Code.
- To describe the authentication systems.
- To analyse the Network Layer Security.

REFERENCE BOOKS:

1. William Stallings, “Cryptography and Network Security: Principles and Practice”, 3rd Edition, Pearson Education, 2002.
2. Behrouz A Forouzan, “Cryptography and Network Security”, Special Edition, Tata McGraw Hill, 2007.
3. Bruce Scheneier, “Applied Cryptography”, John Wiley & Sons, 1994.
4. Charlie Kaufmann, Radia Perlman and Mike Speciner, "Network Security", Second Edition, Prentice Hall, 2002.
5. Douglas R Stinson, “Cryptography: Theory and Practice”, CRC Press Series on Discrete Mathematics and its Applications, 1995.
6. David M Durton, “Elementary Number Theory”, Sixth Edition, Tata Mcgraw Hill, 2009.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	2	-	-	-	-	-	-	-	-	-	1	-	1	1
CO2	3	2	2	-	-	-	1	-	-	-	-	-	1	-	1	1
CO3	3	2	-	3	-	-	-	1	-	-	-	-	1	-	1	1
CO4	2	2	2	3	-	-	-	-	-	-	-	-	1	-	1	1
CO5	3	2	-	-	-	2	-	-	-	-	1	3	1	-	1	1

1911309 HIGH PERFORMANCE SWITCHING ARCHITECTURES L T P C

3 0 0 3

OBJECTIVES:

The student should be made to:

- Understand the basics of switching technologies and their implementation LANs, ATM networks and IP networks.
- Examine the different switching architectures and queuing strategies and their impact on the blocking performances.
- Expose the student to the advancement in packet switching architectures
- Gain knowledge in IP addressing and switching solutions to exploit and integrate the best features of different architectures for high speed switching.
- Analyze the various types of networks.

UNIT - I: LAN SWITCHING TECHNOLOGY 9

Switching Concepts, LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs.

UNIT - II: ATM SWITCHING ARCHITECTURES 9

Blocking networks - basic - and- enhanced banyan networks, sorting networks - merge sorting, re-arrangable networks - full-and- partial connection networks, non blocking networks - Recursive network construction, comparison of non-blocking network, Switching with deflection routing - shuffle switch, tandem banyan switch.

UNIT - III: QUEUES IN ATM SWITCHES 9

Internal Queueing -Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches.

UNIT - IV: PACKET SWITCHING ARCHITECTURES 9

Architectures of Internet Switches and Routers- Bufferless and buffered Crossbar switches, Multi-stage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars.

UNIT - V: IP SWITCHING 9

Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Ipv6 over ATM.

TOTAL PERIODS: 45

OUTCOMES:

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

- Identify suitable switch architectures for a specified networking scenario.
- Demonstrate blocking performance of various switch architectures.
- Apply his knowledge of switching technologies, architectures and buffering strategies for designing a communication network.
- Analyse the performance of various high speed communication networks.
- Examine the various queuing strategies involved in networking.

REFERENCE BOOKS:

1. Achille Pattavina, “Switching Theory: Architectures and performance in Broadband ATM networks "John Wiley & Sons Ltd, New York. 1998.
2. Christopher Y Metz, “Switching protocols & Architectures”, McGraw - Hill Professional Publishing, NewYork.1998.
3. Elhanany M. Hamdi, “High Performance Packet Switching architectures”, Springer Publications, 2007.
4. Rainer Handel, Manfred N Huber, Stefan Schroder, “ATM Networks - Concepts Protocols, Applications”, 3rd Edition, Addison Wesley, New York. 1999.
5. Rich Siefert, Jim Edwards, “The All New Switch Book – The Complete Guide to LAN Switching Technology”, Wiley Publishing, Inc., Second Edition, 2008.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	1	-	-	2	-	-	-	2	3	-	3	3
CO2	3	2	1	1	1	-	-	2	-	-	-	2	3	-	3	3
CO3	3	2	3	3	3	-	-	2	-	-	-	2	3	-	3	3
CO4	3	1	1	1	1	-	-	-	-	-	-	2	3	-	3	3
CO5	3	1	1	3	1	2	2	-	-	-	-	2	3	-	3	3

1911310 PATTERN RECOGNITION AND MACHINE LEARNING L T P C

3 0 0 3

OBJECTIVES:

The objective of this course is to provide knowledge on:

- The fundamentals of pattern classifier.
- Various clustering concepts.
- Various structural pattern recognition and feature extraction.
- The basic of concept learning and decision trees.
- Recent advancement in pattern recognition.

UNIT-I: PATTERN CLASSIFIER 9

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier.

UNIT-II: CLUSTERING 9

Clustering for unsupervised learning and classification -Clustering concept – C-means algorithm –Hierarchical clustering procedures -Graph theoretic approach to pattern clustering -Validity of clusters.

UNIT-III: FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION 9

KL Transforms – Feature selection through functional approximation – Binary selection -Elements of formal grammars - Syntactic description - Stochastic grammars –Structural representation.

UNIT-IV: INTRODUCTION, CONCEPT LEARNING AND DECISION TREES 9

Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

UNIT-V: RECENT ADVANCES 9

Neural network structures for pattern recognition -Neural network based pattern associators –Unsupervised learning in neural pattern recognition -Self organizing

networks -Fuzzy logic -Fuzzy pattern classifiers -Pattern classification using Genetic Algorithms.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Classify the data and identify the patterns.
- Utilize the given data set to extract and select features for Pattern recognition.
- Understand Version Spaces and Candidate Elimination for based on decision trees.
- Describe the decision tree and concept learning.
- Discuss on recent advances in pattern recognition.

REFERENCE BOOKS:

1. Duda R.O., and Hart.P.E., “Pattern Classification and Scene Analysis”, Wiley, New York, 1973.
2. Morton Nadier and Eric Smith P., “Pattern Recognition Engineering”, John Wiley & Sons, New York, 1993.
3. Narasimha Murty M and Susheela Devi V, “Pattern Recognition – An Algorithmic Approach”, Springer, Universities Press, 2011.
4. Robert J.Schalkoff, “Pattern Recognition: Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 2007.
5. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (Indian Edition), 2013.
6. Tou and Gonzalez, “Pattern Recognition Principles”, Wesley Publication Company, London, 1974.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	-	-	-	2	2	3	-	1	-	-	-	-
CO2	2	2	-	2	-	-	-	-	2	-	-	1	-	-	-	-
CO3	3	2	1	3	-	2	-	2	-	1	-	2	-	-	-	-
CO4	3	3	3	3	-	2	-	2	2	2	-	2	-	-	-	-
CO5	3	-	2	2	-	3	3	2	3	3	-	2	-	-	-	-

1912304 SPEECH PROCESSING AND SYNTHESIS L T P C

3 0 0 3

OBJECTIVES:

- To understand the mathematical foundations needed for speech processing.
- To understand the basic concepts and algorithms of speech processing and synthesis.
- To familiarize the students with the various speech signal representation.
- To know about coding and recognition techniques.
- To appreciate the use of speech processing in current technologies and to expose the students to real– world applications of speech processing.

UNIT - I: FUNDAMENTALS OF SPEECH PROCESSING 9

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

UNIT - II: SPEECH SIGNAL REPRESENTATIONS AND CODING 9

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

UNIT - III: SPEECH RECOGNITION 9

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

UNIT - IV: TEXT ANALYSIS 9

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

UNIT - V: SPEECH SYNTHESIS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the various features required for identifying speech units – phoneme, syllable and word.
- Determine and apply different speech signal representation for the complex problems.
- Justify the use of different speech recognition and its limitations.
- Identify the apt approach of text analysis depending on the language to be processed.
- Determine the use of formant and concatenative speech synthesis.

REFERENCE BOOKS :

1. Joseph Mariani,-Language and Speech Processing,Wiley,2013.
2. Lawrence Rabiner and Biing-Hwang Juang, -Fundamentals of Speech Recognition‖, Prentice Hall Signal Processing Series, 1993.
3. Sadaoki Furui,-Digital Speech Processing: Synthesis, and Recognition, Second Edition,(Signal Processing and Communications),Marcel Dekker, 2000.
4. Thomas F.Quatieri,-Discrete-Time Speech Signal Processing‖, Pearson Education,2002.
5. Xuedong Huang ,AlexAcero, Hsiao-Wuen Hon,-Spoken Language Processing– A guide to Theory, Algorithm and System Development‖, Prentice Hall PTR, 2001.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	-	2	-	-	-	-	-	-	-	-	3	-	3	3
CO2	-	2	-	2	-	-	-	-	-	-	-	1	3	-	3	3
CO3	-	2		2	-	-	1		1	-	-	-	3	-	3	3
CO4	-	3	2	1	-	-	-	-	-	-	-	-	3	-	3	3
CO5	-	-	2	-	-	2	-	-	1	-	-	-	3	-	3	3