PUDUCHERRY TECHNOLOGICAL UNIVERSITY
PUDUCHERRY–605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi

of

M.Tech. in Electronics and Communication Engineering

(With effect from Academic year 2020-21)

(Approved in the Sixth Academic Council Meeting held on 20th March 2021)

CURRICULUM

The curriculum of M.Tech. (Electronics and Communication Engineering) is designed to fulfill the Programme Educational Objectives (PEO) and Programme Outcomes (PO) listed below:

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	To produce scholarly and competitive graduates in the core areas of Electronics and Communication engineering.
PEO2	To inculcate intellectual capacity, research aptitude and independent thinking to inquire, study and explore the frontier areas of the domain.
PEO3	To arouse the interest for application centric learning through intensive laboratory practices towards producing confident and industry ready human resource.
PEO4	To nurture and evoke the spirit of innovation, creativity, risk taking ability and entrepreneurship
PEO5	To develop life skills, ethical disposition and sensitivity towards environment and safety.

PROGRAMME OUTCOMES (PO)

PO1	Ability to evolve as knowledgeable and competitive graduates with a global perspective in the areas of Electronics and Communication Engineering.
PO2	Ability to be innovative and develop aptitude for independent research and development.
PO3	Ability to demonstrate a degree of mastery in the areas of Electronics and Communication Engineering.
PO4	Ability to apply the knowledge of science, mathematics and engineering principles and propose ingenious solutions to practical problems with due considerations for public health and safety, cultural, societal and environmental factors.
PO5	Ability to contribute to the technological advances through quality research.
PO6	Capacity for applying knowledge, modern techniques and tools to design and conduct experiments as well as to analyze and interpret data to build practical systems.
PO7	Ability to collaborate and work in a multi-disciplinary environment towards higher academic and research objectives.
PO8	Understanding of engineering and management principles to lead and manage projects efficiently towards fulfilling the envisaged outcomes.
PO9	Ability to articulate and present the ideas and thoughts precisely and with clarity.
PO10	Ability to engage in life-long learning with commitment to stay relevant and contemporary.
PO11	Ability to understand and appreciate ethical principles and social responsibilities.
PO12	Ability to take on challenging issues, be progressive in endeavours and learn from the outcomes.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1	Ability to identify, formulate, design and solve engineering challenges in RF Communication Systems using VLSI tools and Communication & Networking Platforms.
PSO2	Explore evolving technologies in VLSI, SoC, RF Systems, Antennas, Wireless Communication, Wireless Networks, Optical and Satellite Communication, and Communication Standards.
PSO3	Ability to understand and use contemporary Software tools for Design, Analysis and Verification of VLSI, Communication and Networking Systems.

Distribution of Credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl. No.	Category	Credits	Course Category Code (CCC)
1	Programme Core Course	24	PCC
2	Programme Specific Elective Courses	15	PSE
3	Open Elective Courses	03	OEC
4	Professional Activity Courses (Project Work, Seminar)	28	PAC
5	Mandatory Audit Courses	Non - Credit	MAC
	Total	**70**	

Semester Wise Courses and Credits

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MA251	Probability and Stochastic Process	**PCC**	3	0	0	3
EC251	Advanced Digital Communication	**PCC**	3	0	0	3
EC252	Advanced Digital Signal Processing	**PCC**	3	0	0	3
ECZNN	Programme Specific Elective - 1	**PSE**	3	0	0	3
ECZNN	Programme Specific Elective - 2	**PSE**	3	0	0	3
EC253	Advanced Communication Systems Laboratory	**PCC**	0	0	4	2
EC254	Research Methodology and IPR	**PCC**	2	0	0	2
AD2NN	Audit Course - I	**MAC**	2	0	0	0
Total			**23**			**19**

Semester II

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EC255	RF System Design	**PCC**	3	0	0	3
EC256	Advanced Radiating Systems	**PCC**	3	0	0	3
EC257	Low Power CMOS VLSI Circuit Design	**PCC**	3	0	0	3
ECZNN	Programme Specific Elective - 3	**PSE**	3	0	0	3
ECZNN	Programme Specific Elective - 4	**PSE**	3	0	0	3
EC258	VLSI Laboratory	**PCC**	0	0	4	2
EC259	Mini Project and Seminar	**PAC**	0	0	4	2
AD2NN	Audit Course – II	**MAC**	2	0	0	0
Total			**25**			**19**

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
ECZNN	Programme Specific Elective - 5	**PSE**	3	0	0	3
OE2NN	Open Elective	**OEC**	3	0	0	3
EC260	Dissertation – Phase I	**PAC**	0	0	20	10
Total			**26**			**16**

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EC261	Dissertation – Phase II	**PAC**	0	0	32	16
Total			**32**			**16**

Audit Courses (MAC)

AD201	English for Academic Writing
AD202	Disaster Management
AD203	Value Education
AD204	Constitution of India
AD205	Pedagogy Studies
AD206	Stress Management by Yoga

Open Elective Courses (OEC)

OE201	Business Analytics (IT)
OE202	Industrial Safety and Maintenance (ME)
OE203	Operations Research (ME)
OE204	Cost Management of Engineering Projects (CE)
OE205	Composite Materials (PH)
OE206	Waste to Energy (CE)

Programme Specific Electives (PSE):

	M.Tech (ECE)		
I sem	**PSE - 1**	**ECZ01**	Mobile Satellite Communication
		ECZ02	Free Space Optical Communication
		ECZ03	Cognitive Radio
		ECZ04	Multimedia Communication Systems
I sem	**PSE -2**	**ECZ05**	Embedded Systems & RTOS
		ECZ06	High Speed Networks
		ECZ07	Optical Networks
		ECZ08	DSP Architectures
II sem	**PSE -3**	**ECZ09**	Communication Networks Modeling and Simulation
		ECZ10	Radio over Fiber systems
		ECZ11	Wireless Sensor Networks
		ECZ12	Digital Communication Receivers
II sem	**PSE - 4**	**ECZ13**	Ubiquitous Computing
		ECZ14	Reconfigurable Computing
		ECZ15	Cryptography and Network Security
		ECZ16	Speech and Audio signal processing
III sem	**PSE - 5**	**ECZ17**	Pattern recognition and Machine learning
		ECZ18	Digital Image & Video Processing
		ECZ19	Audio Coding and Compression
		ECZ20	Optimization techniques

Department: **Mathematics**		Programme:**M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**		Course Category Code:**PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
MA251	**Probability and Stochastic Processes**	3	-	-	3	40	60	100
Prerequisite	Basic Probability							

Course Outcome		
	CO1	Construct sample spaces of random experiments and identify the distributions
	CO2	Apply Continuous distributions and solve problems.
	CO3	Transforms random variables and find the relationship between distributions.
	CO4	Able to apply Stochastic processes and solve Problems
	CO5	Solve Queuing theory problems

UNIT I	**Random Variables-Discrete Random Variables**	**Periods** : **9**
Random Variables and their Probability Distributions: Random variables, Probability distribution function, Probability density function, Conditional probability, Statistical Independence, Bayes formula. Discrete Random Variables and their Distributions, Moment Generation Function, Characteristics Function, Probability generating function, Binomial Distribution, Negative Binomial Distribution, Hyper geometric distribution, Multinomial, Poisson Distributions, Relationship between various Discrete-Type distributions.		**CO1**
UNIT II	**Continuous Random Variables**	**Periods** : **9**
Continuous Random Variables and their Distributions Normal, Log - Normal, Multivariate Normal, Gamma, Exponential, Chi-square, Weibull, Rayleigh distributions. Relationship between continuous distributions.		**CO2**
UNIT III	**Transformation of Random Variables**	**Periods** : **9**
Transformation of Random Variables: Transformation of Single, Several Random Variables, Function of Random Variables, Sum, Differences, Product and Ratio of Two Random Variables, Transformation through characteristic Functions.		**CO3**
UNIT IV	**Stochastic Processes**	**Periods** : **9**
Stochastic Processes Introduction- Classification of stochastic process, Stationary process (SSS and WSS) Stationary process, Ergodic Process, Independent increment Process, Markov Process, Counting Process, Narrow- Band Process, Normal Process, Wiener-Levy Process, Poisson, Bernoulli, Shot noise Process, Autocorrelation Function.		**CO4**
UNIT V	**Queueing Models**	**Periods** : **9**
Introduction, Little's formula, Continuous Parameter Markov Chain: The Birth and Death process: M/M/1, M/M/c, M/M/1/N, M/M/c/N (c <N), M/M/c/c, M/M/∞ models only - derivation of mean number of customer in the system, in the queue and waiting time - Simple applications, Special case of Birth and Death model (Pure Birth and Pure Death Processes).		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books

1. KishorS.Trivedi, "Probability and Statistics with Reliability", Queueing and Computer Science Application, John Wiley & Sons Inc. Second Edition, 2002.
2. D.Gross and C.M.Harris, "Fundamentals of Queueing Theory", Wiley Students Edition, Third Edition, 1985.
3. J.Medhi, "Stochastic Processes", New Age International (P) Ltd., Second Edition, 2012.
4. J.Medhi, "Stochastic models in Queueing Theory", Academic Press, Second Edition, 2012.

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC251	**Advanced Digital Communication**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Knowledge on fundamentals of Information and channel capacity							
	CO2	Ability to analyze the performance of different error control codes							
	CO3	Knowledge on various modulation schemes and its performance on transmitted signal							
	CO4	Ability to analyze the signaling over AWGN channels							
	CO5	Knowledge on analysis of information over band limited channels with equalization techniques							

UNIT I	**Information Theory**	**Periods :9**
Information Measure and Entropy - Source coding and Shannon's Theorem - Source coding for Discrete Memoryless Sources - Discrete Memoryless Channels - Mutual Information and Channel capacity - Channel Coding Theorem - Continuous Sources and Differential Entropy.		**CO1**
UNIT II	**Channel Coding**	**Periods :9**
Error control using forward error correction-discrete memoryless channels-linear block codes-cyclic codes-convolutional codes-illustrative procedure for MAP decoding in the log domain-new generation of probabilistic compound codes-Turbo Codes-Low density parity check codes-Trellis coded modulation- Concatenated codes-BCH codes.		**CO2**
UNIT III	**Digital Modulation Schemes**	**Periods :9**
Elements of digital communication system - Review of Line coding - Representation of Digitally Modulated Signals - Memory less modulation methods - Signaling Scheme with memory - Power spectrum of digitally modulated signals – Modulation for Multi carrier communication - Synchronization.		**CO3**
UNIT IV	**Digital Receivers**	**Periods :9**
Waveform and vector Channel models - Waveform and vector AWGN Channel - Optimum detection and error probability for band limited signaling and power limited signaling- Non-Coherent detection - Comparison of digital signaling methods - Optimum receiver for CPM – Multi carrier communication receivers.		**CO4**
UNIT V	**ISI and Equalization**	**Periods:9**
Characterization of Band Limited Channels - Nyquist Criterion for zero ISI - Controlled ISI channel with ISI and AWGN - Pulse Shaping for optimum transmission and reception – MLSE - Linear Equalization - Decision feedback equalization - ML detectors - Turbo and Blind Equalization methods.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. John G. Proakis and Masoud Salehi, "Digital Communications," 5th edition, Tata McGraw Hill, 2014.
2. Bernard Sklar, "Digital Communications: Fundamentals and Applications", 3rd edition, Pearson Education, 2020.
3. Marvin K. Simon, Sami M. Hinedi and William C. Lindsey, "Digital Communication Techniques: Signal Design and Detection", Prentice Hall of India, 2009.
4. Ian A. Glover and Peter M. Grant, "Digital communications", 2nd edition, Pearson Education, 2008.

Websites

1. www.nptel.ac.in
2. https://books.google.co.in

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2		1				2						2	1	1
CO2	2	2	2			2	1						3	3	2
CO3	3	3	3	3	2	3		2		3			3	3	2
CO4	3	3	3	3	2	2				3			3	3	2
CO5	2	2	2	2		3		2					2	3	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC252	**Advanced Digital Signal Processing**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Characterize and Analyze Discrete Time Random Processes							
	CO2	Model Random Processes for Linear Prediction and Estimation							
	CO3	Estimate the Spectrum of Random Processes							
	CO4	Design LMS Wiener Filters for Filtering and Prediction							
	CO5	Develop Adaptive Filter Algorithms for Nonstationary Random Processes							

UNIT I	**Discrete Time Random Signal Processing**	**Periods** : **9**
Discrete Random Processes – Ensemble averages, Stationary Processes, Autocorrelation and Autocovariance Matrices, Ergodicity. Parseval's Theorem, Wiener-Khintchine Relation, White Noise, Power Spectral Density, Spectral Factorization, Filtering Random Processes, Filtering White Noise. Parameter Estimation: Bias and Consistency.		**CO1**
UNIT II	**Signal Modelling and Linear Prediction**	**Periods** : **9**
ARMA(p,q), AR(p) and MA(q) models for random processes. Linear Prediction – Forward Linear Prediction and Backward Linear Prediction. Solution to Normal Equations, Levinson-Durbin Algorithm.		**CO2**
UNIT III	**Spectrum Estimation**	**Periods** : **9**
Spectrum Estimation for Finite Duration Signals, Nonparametric Methods – Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey Methods. Parametric Methods – ARMA, AR and MA Model based Spectral Estimation.		**CO3**
UNIT IV	**Linear Estimation**	**Periods** : **9**
Least Mean Square Error Criterion – Wiener Filter for Filtering and Prediction, FIR Wiener Filter, Causal IIR Wiener Filter, Noncausal IIR Wiener Filter.		**CO4**
UNIT V	**Adaptive Filters**	**Periods** : **9**
FIR Adaptive Filters – Adaptive Filter based on Steepest Descent Method – Widrow-Hopf LMS Adaptive Algorithm, Normalized LMS Algorithm. Adaptive Channel Equalization, Adaptive Echo Cancellation, Adaptive Noise Cancellation. RLS Adaptive Filters - Exponentially Weighted RLS – Sliding Window RLS.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Monson H.Hayes, "Statistical Signal Processing and Modelling", Wiley India, 2008.
2. Simon Haykin, "Adaptive Filter Theory", Fourth Edition, Pearson India, 2002.
3. John G.Proakis et.al., "Algorithms for Statistical Signal Processing", Pearson Education, 2002.
4. Dimitris G.Manolakis et.al., "Statistical and Adaptive Signal Processing", McGraw Hill, New York 2000.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	3	3	3	1	1	1	1	1	1	1	3	2	1
CO2	3	3	3	3	3	1	1	1	1	1	1	1	3	2	1
CO3	3	3	3	3	3	1	1	1	1	1	1	1	3	2	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1	3	2	1
CO5	3	3	3	3	3	1	1	1	1	1	1	1	3	2	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **First**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
EC253	**Advanced Communication Systems Laboratory**	-	-	4	2	40	60	100
Prerequisite	Fundamentals of Communication Engineering, Coding and Networks							
Course Outcome	**CO1**	Ability to demonstrate the design of modulator, antenna and different coding techniques suitable wireless scenario						
	CO2	Ability to simulate the GSM network and study the different schemes and analyze the parameters						
	CO3	To understand the working of some wireless communication system models						

List of Experiments :

1. Design of DS-SS and study the signals using spectrum analyzer 2. Design and testing of Yagi-Uda antenna using vector network analyzer 3. Study of error detection and correction codes using Matlab Simulink 4. Design and implementation of digital filter for speech coding	**CO1**
5. Design of GMSK modulator for GSM system. 6. Call Establishment of GSM,CDMA and ZIGBEE network through simulation. 7. Performance analysis of QPSK and QAM using Simulink 8. Simulation of OFDM transmitter and receiver using Matlab or equivalent. 9. Study and security algorithms for images using Matlab or equivalent	**CO2**
10.Routing and wavelength assignment algorithm for WDM optical network 11. Development of any one network topology, establish a routing protocol and analyse using NS2. 12.Simulation of wireless sensor network and its performance evaluation. 13.Study of satellite link design. 14. Modeling the 802.11 environment and study of the performance at network level and link level.	**CO3**

Lecture Periods: -	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

1. John G. Proakis and Masoud Salehi, "Digital Communications," 5th edition, Tata McGraw Hill, 2008.
2. Ian A. Glover and Peter M. Grant, "Digital communications", 2nd edition, Pearson education, 2008.
3. Holger Karl, Andreaswillig, "Protocol and Architecture for Wireless Sensor Networks", John wiley publication, Jan 2006.
4. Marvin K. Simon, Sami M. Hinedi and William C. Lindsey, "Digital Communication Techniques: Signal Design and Detection", Prentice Hall of India, 2009.
5. Dennis Roddy, "Satellite Communication", 3rd edition, 2009.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	3	3	2	2	2	1	1	1	1	1	3	2	1
CO2	3	3	3	3	2	2	2	1	1	1	1	2	3	2	1
CO3	3	3	3	3	2	2	2	1	1	1	1	3	3	2	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC254	**Research Methodology and IPR**		2	-	-	2	40	60	100
Prerequisite									
Course Outcome	**CO1**	Understand research problem formulation and methods							
	CO2	Analyze research related information and follow research ethics							
	CO3	Gain competency in writing a research paper and proposal							
	CO4	Comprehend the need for IPR for growth of individuals & nation.							
	CO5	Be aware that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.							

UNIT I	**Research problem formulation**	**Periods** : **6**
Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary methods.		**CO1**
UNIT II	**Research procedure and ethics**	**Periods** : **6**
Effective literature studies approaches, analysis, Plagiarism, Research ethics		**CO2**
UNIT III	**Outcomes of Research**	**Periods** : **6**
Effective technical writing, how to write report/ Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.		**CO3**
UNIT IV	**Intellectual Property**	**Periods** : **6**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		**CO4**
UNIT V	**Patent Rights**	**Periods** : **6**
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System		**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction , Second edition , Juta & Co, 2007
2. Kothari, C.R., Research Methodology-Methods and Techniques, Wiley Eastern Limited, New Delhi, 2020.
3. Ranjit Kumar, , "Research Methodology: A Step by Step Guide for beginners", 2nd Edition, Pearson Education, Singapore, 2005.
4. D.J.Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	3	2	3	3	3	3	3	2	3	1	2	3	3	2
CO2	2	3	2	3	3	3	3	2	2	2	3	1	3	3	2
CO3	2	3	2	3	3	3	2	3	3	2	2	2	3	3	1
CO4	2	3	2	3	3	3	2	2	2	2	2	2	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2	3	3	3	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name:	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
EC255	**RF System Design**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	Gain knowledge on contemporary transceiver architectures
	CO2	Study various categories of amplifiers used in RF transceivers
	CO3	Understand the principle and design of RF Mixers and Oscillators
	CO4	Examine the design and performance of PLL and frequency synthesizers
	CO5	Ability to design and implement different types of RF filter

UNIT I	**Transceiver Architectures**	**Periods** : **9**
Basic concepts in RF design - Nonlinearity and its effects - Gain compression - Cross modulation- Intermodulation- Noise as a random process- noise spectrum - Device noise - Representation of noise in circuits - Noise figure - Sensitivity and dynamic range Transceiver Architectures: General considerations - Receiver Architectures : Basic Heterodyne and Modern Heterodyne receivers- Direct Conversion receivers- Image reject Receivers -Low IF Architectures. Transmitter Architectures: Direct Conversion transmitters- Modern DC transmitters- Heterodyne transmitters		**CO1**
UNIT II	**Passive devices and RF Amplifiers**	**Periods** : **9**
Passive devices - Inductors - Basic structure, geometries, inductance equation - Loss mechanisms - Varactors- Constant capacitors Amplifiers: Open circuit time constant method for bandwidth estimation for CG and CS Amplifiers –High frequency amplifier design - Shunt and series peaked amplifiers - Shunt -series amplifiers- Bandwidth Enhancement with ft doublers - Tuned amplifiers - Cascaded amplifiers - Low Noise Amplifiers: Power match versus Noise match– Inductively degenerated CS amplifier - Single ended and Differential LNAs.		**CO2**
UNIT III	**RF Mixers and Oscillators**	**Periods** : **9**
Mixer: characteristics–Non-linear systems as Linear mixers – Square law mixer - Multiplier based mixers - Single balanced and double balanced mixers – Sub sampling mixers. Oscillators: Describing function model - Colpitts oscillators analysis - Tuned oscillators - LC Feedback Oscillators - Crystal Oscillators - Negative resistance oscillators-Resonator technologies.		**CO3**
UNIT IV	**PLL and Frequency Synthesizers**	**Periods** : **9**
PLL: Linearised Model–Noise properties–Phase detectors–Loop filters and Charge pumps. Frequency Synthesizers: Frequency Synthesizers with Static moduli - Modified PLL type - Integer N – Frequency Synthesizers with Dithering moduli - Combination Synthesizers - Direct Digital Frequency synthesizers.		**CO4**
UNIT V	**RF Filters**	**Periods** : **9**
Filter types and Parameters - Special Filter Realizations - Butterworth and Chebyshev type Filters- Denormalization of standard Low pass filter - Frequency transformation and Impedance transformation - Filter implementation with unit elements.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. B. Razavi, “RF Microelectronics”, Second edition, Pearson Education, 2012.
2. Thomas. H.Lee, “The Design of CMOS Radio Frequency Integrated Circuits”, Cambridge University Press, 2004.
3. Reinhold Ludwig and Pavel Bretchko, “RF Circuit design, Theory and Applications”, Prentice Hall, 2009.
4. David M. Pozar, “Microwave and RF Wireless systems”, John Wiley & Sons, 2000.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	3	3	3	3	1	1	2	2	1	2	2	3	1
CO2	3	2	3	3	3	3	1	1	2	2	1	2	2	3	1
CO3	3	2	3	3	3	3	1	1	2	2	1	2	2	3	1
CO4	3	2	3	3	3	3	1	1	2	2	1	2	2	3	1
CO5	3	2	3	3	3	3	1	1	2	2	1	2	2	3	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name:		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC256	**Advanced Radiating Systems**		3	-	-	3	40	60	100
Prerequisite	Electromagnetics and Antenna theory								
Course Outcome	**CO1**	Understand the fundamentals of antennas and various antenna parameters							
	CO2	Acquire knowledge of aperture antennas and the fields associated with it							
	CO3	Design special array antennas							
	CO4	Describe about Microstrip patch antennas and their applications							
	CO5	Learn measurement of antenna parameters and Smart Antennas							

UNIT I	**Concept of Radiation**	**Periods** : **9**
Physical concept of radiation-radiation from surface and line current distributions- Field regions-Reciprocity and Reaction Theorem-Directional and omnidirectional Patterns-Numerical Techniques-effective aperture- gain-polarization - Antenna Vector Effective length and equivalent areas-Radiation integrals and axillary potential functions		**CO1**
UNIT II	**Radiation from Apertures**	**Periods** : **9**
Field equivalence Principle : Huygen's principle-Analysis of radiation characteristics of rectangular and circular aperture Antennas- Uniform distribution on an infinite ground plane- TE_{10} and TE_{11} mode distribution on an infinite ground plane- Beam efficiency- Design considerations- Babinet's principle-Dielectric covered apertures- Ground plane edge effect using GTD method-Applications		**CO2**
UNIT III	**Antenna Arrays**	**Periods** : **9**
Linear array-uniform array-end fire and broadside-gain-beamwidth, side lobe level- Two dimensional uniform array- phased array- Beam scanning-grating lobe-feed network-linear array synthesis techniques- Binomial and Chebyshev distributions		**CO3**
UNIT IV	**Microstrip Antenna**	**Periods** : **9**
Radiation mechanism and excitation techniques-Microstrip dipole-rectangular patch circular patch-radiation analysis by cavity model-Microstrip array-Microstrip broadband antennas-Log periodic antenna-Biconical antenna-multiturn loop antenna		**CO4**
UNIT V	**Smart Antennas and Measurement**	**Periods** : **9**
Adaptive antenna systems-wideband smart antennas-digital radio receiver and software radio for smart antennas-5G massive MIMO antennas-antenna measurement and instrumentation-gain, impedance and antenna factor measurement - antenna test range design		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Hubregt.J.Visser, "Antenna Theory and Applications", 1st Edition, John Wiley & Sons Ltd, New York, 2012.
2. Elliot, "Antenna Theory and Design", IEEE press, 2003.
3. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 2012.
4. Krauss.J.D, "Antennas", II edition, John Wiley and sons, New York, 1997.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2							2			3		
CO2	3	2	3							3	2			3	
CO3	3		3							3	2				3
CO4	3		3			2	2			3			3		
CO5	3				1	1				2					3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
EC257	**Low Power CMOS VLSI Circuit Design**	3	-	-	3	40	60	100
Prerequisite	VLSI Design							

Course Outcome	**CO1**	Gain knowledge on sources of power dissipation and the technology impact on low power
	CO2	Estimate the power dissipation by employing simulations and probabilistic techniques
	CO3	Understand the diverse approaches employed at circuit and logic level to achieve low power
	CO4	Design the low power circuits at the system level
	CO5	Understand the different approaches of low power clock distribution and methodologies employed at the algorithm and at the architectural level

UNIT I	**Introduction to Low Power VLSI Design**	**Periods** : **9**
Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Physics of power dissipation in CMOS devices. Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.		**]CO1**
UNIT II	**Power estimation**	**Periods** : **9**
Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, Data Correlation Analysis in DSP Systems, Monte Carlo simulation. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.		**CO2**
UNIT III	**Low Power Design**	**Periods** : **9**
Circuit level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library. Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.		**CO3**
UNIT IV	**Low Power Architecture & Systems**	**Periods** : **9**
Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.		**CO4**
UNIT V	**Low power Clock Distribution**	**Periods** : **9**
Power dissipation in clock distribution, single driver vs distributed buffers, Zero skew vs tolerable skew, chip & package co design of clock network. Algorithm and Architectural Level Methodologies: Introduction, design flow, Algorithmic level analysis and optimization, Architectural level estimation & synthesis.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, 2009.
2. Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 2002.
3. Rabaey, Pedram, "Low Power Design Methodologies", Kluwer Academic Press, 2009.
4. Angsuman Sarkar, Swapnadip De, Manash Chanda & Chandan Kumar Sarkar, "Low Power VLSI Design", De Gruyter Oldenbourg, 2016.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	3	2	2	1	1	1	2	3	3	2
CO2	3	3	3	3	3	3	2	2	1	1	1	2	3	3	2
CO3	3	3	3	3	3	3	2	2	1	1	1	2	3	3	2
CO4	3	3	3	3	3	3	2	2	1	1	1	2	3	3	2
CO5	3	3	3	3	3	3	2	2	1	1	1	2	3	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC258	**VLSI Laboratory**		-	-	4	2	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Able to use the functional simulation tools like Xilinx and Modelsim and can analyze static timing violation							
	CO2	Perform synthesis and emulate the design using the target FPGA board							
	CO3	Can generate layout and analyze design rule violations of the circuit under test.							

List of Experiments: Digital System Design, Signal Processing and MOSFET	
Part I:Design and Functional Verification of combinational and sequential circuits using VerilogHDL at any level(Gate level or Dataflow or Behavioral) 1. Design and verification of a 4-bit and 16-bit adder by employing different adder structures. 2. Design and verification of 8-bit magnitude comparator, 8-bit parity generator and an 8-bit parallel adder/subtractor. 3. Perform static timing analysis of a 4-bit synchronous and ripple counter and also design a linear feedback shift register by choosing a primitive polynomial to generate the test patterns and verify its functionality. 4. Design and verification of 4-bit multiplier using Booth's encoding and Wallace Tree multiplier structure. 5. Design and verification of 4-bit barrel shifter and a 16-bit ALU. 6. Design and verify a 16-bit floating point addition/subtraction operation. 7. Design and verify 16-bit floating point multiply and divide operation. 8. Design a radix-2 8-point FFT architecture by employing decimation in time.	**CO1**
Part II: Design Implementation using FPGA: 9. Perform synthesis and generate RTL schematic of 4-bit matrix keypad using Spartan6 FPGA. 10. Design and implementation of UART using Spartan6 FPGA. 11. Xilinx IP core Design using Spartan6 FPGA.	**CO2**
Part III: Using any of the EDA tools(Cadence, Microwind or TannerEDA) generate layout: 12. Design and generate layout of CMOS inverter, CMOS NAND and CMOS NOR gate. 13. Design and generate layout of CMOS differential amplifier. 14. Design and generate layout of the given function using pass transistor logic and transmission gate logic. 15. Design and generate layout of 4-bit counter.	**CO3**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

1. VLSI Lab Manual, Department of ECE, Pondicherry Engineering College.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	3	3	2	3	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	2	3	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PAC**			Semester Exam Type: **LB**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC259	**Mini Project and Seminar**		-	-	4	2	100	-	100
Prerequisite	-								
Course Outcome	**CO1**	Ability to carry out a portion of a research work							
	CO2	Ability to extend the project to find an application for society							
	CO3	Ability to work in a team and present the ideas and thoughts with a clarity							

Mini Project	
In the course of the degree Programme each group of not more than two students has to identify a mini project work in the area of their specialization and the mini project will be implemented under the supervision of a faculty. The progress of the work will be monitored and assessed internally. A project report has to be submitted at the end of the semester after completion of the project work.	**CO1, CO2, CO3**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO2	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="3">Department: Electronics and Communication Engineering</td><td colspan="6">Programme: M.Tech.(Electronics and Communication Engineering)</td></tr>
<tr><td colspan="3">Semester: Third</td><td colspan="3">Course Category Code: PAC</td><td colspan="3">Semester Exam Type: PR</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td></td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EC260</td><td colspan="2">Dissertation – Phase I</td><td>-</td><td>-</td><td>20</td><td>10</td><td>250</td><td>250</td><td>500</td></tr>
<tr><td>Prerequisite</td><td colspan="8">-</td></tr>
<tr><td rowspan="3">Course Outcome</td><td>CO1</td><td colspan="7">Ability to transform knowledge into an experimental process</td></tr>
<tr><td>CO2</td><td colspan="7">Ability to demonstrate the motivation to extend the work to a research</td></tr>
<tr><td>CO3</td><td colspan="7">Ability to identify and apply appropriate tools to solve a problem and also has the capability to examine hypotheses</td></tr>
<tr><td colspan="8">Each student will do an exhaustive literature survey and identify an experimental and / or a theoretical project to be carried out under a supervision of a guide. The phase I of the project work has to be completed by the end of third semester. The progress of the work will be monitored and assessed internally for 250 marks by a committee comprising departmental faculty members and project guide. A project report has to be submitted at the end of the semester after completion of the phase I of the project work. The external assessment will be carried out for 250 marks as per regulations.</td><td>CO1, CO2, CO3</td></tr>
<tr><td colspan="3">Lecture Periods: -</td><td colspan="2">Tutorial Periods: -</td><td colspan="2">Practical Periods: 300</td><td colspan="2">Total Periods: 300</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO2	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="4">Department: Electronics and Communication Engineering</td><td colspan="5">Programme: M.Tech.(Electronics and Communication Engineering)</td></tr>
<tr><td colspan="4">Semester: Fourth</td><td colspan="3">Course Category Code: PAC</td><td colspan="2">Semester Exam Type: PR</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td></td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EC261</td><td>Dissertation – Phase II</td><td>-</td><td>-</td><td>32</td><td>16</td><td>250</td><td>250</td><td>500</td></tr>
<tr><td>Prerequisite</td><td colspan="8">-</td></tr>
<tr><td rowspan="3">Course Outcome</td><td>CO1</td><td colspan="7">Ability to transform knowledge into an experimental process</td></tr>
<tr><td>CO2</td><td colspan="7">Ability to demonstrate the motivation to extend the work to a research</td></tr>
<tr><td>CO3</td><td colspan="7">Ability to identify and apply appropriate tools to solve a problem and also has the capability to examine hypotheses</td></tr>
<tr><td colspan="8">The phase II of the project work has to be completed by the end of the fourth semester. The progress of the work will be monitored and assessed internally for 250 marks by a committee comprising departmental faculty members and project guide. A project report summarizing the entire project work has to be submitted at the end of the semester after completion of the phase II of the project work. The external evaluation will be carried out as per regulations for 250 marks.</td><td>CO1, CO2, CO3</td></tr>
<tr><td colspan="2">Lecture Periods: -</td><td colspan="2">Tutorial Periods: -</td><td colspan="2">Practical Periods: 480</td><td colspan="2">Total Periods: 480</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO2	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

PROGRAMME SPECIFIC ELECTIVES

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ01	**Mobile Satellite Communication**		3	-	-	3	40	60	100
Prerequisite	Basics of Satellite Communication								
Course Outcome	**CO1**	Introduce the ideas and need for satellite communication							
	CO2	Familiar with the fundamentals of mobile satellite communication							
	CO3	Knowledgeable in identifying the constituents of signaling and Mobility management							
	CO4	Capability to show the challenges in Handover controlling schemes							
	CO5	Ability to demonstrate the possible Integration scenarios for various applications							

UNIT I	**Introduction**	**Periods** : **9**
Evolution – Mobile Satellite system Architecture – Types – Categorization of MSS – Regulatory considerations –operational considerations-Mobile systems- A Comparison-Universal mobile communication system – concepts and trends-Design objectives – Network availability – Reliability – Service coverage – Network capacity – Characteristics of mobile services through terrestrial and satellite media – Applications of MSS - Network model of generic MSS system in an OSI hierarchy		**CO1**
UNIT II	**Mobile Satellite Network**	**Periods** : **9**
Satellite personal communication networks –Typical MSS Network architecture –MSS system requirements-Spectrum Issues- Operational frequency – Logical channels – Traffic channel – Control channel – Equations of satellite orbit –Model for Interference calculation-Propagation characteristics-Ionosphere effects-Land mobile Channel –Maritime channel -Aeronautical Channel – System Implications-Environmental issues- Biological effects		**CO2**
UNIT III	**S-PCN Signaling and Mobility Management**	**Periods** : **9**
Overview of GSM signaling – S-PCN interfaces & Signaling protocol architecture – Functional interfaces of a GMR system – Mobility management – Inter satellite Links-call routing – connectivity -Satellite cells and Satellite location areas –Location Management – Location updates - GCA approach – Terminal based approach – Handover management – Handover strategies – Handover controlling schemes – Resource management – Effects of satellite system characteristics – Effects of mobility – Fixed Earth stations and Hand held user terminals-service requirements		**CO3**
UNIT IV	**Integrated Terrestrial - Satellite Mobile Network**	**Periods** : **9**
Integration with PSTN – Gateway functions and operations – Protocol architecture of SS7 – Access functions –Integration with GSM – Integration Requirements – User requirements – Network operator requirements –Integration scenarios – Integration at BSC, MSC, BTS, GTS, GSC and GMSC – Dual mode terminal in terrestrial/SPCN integration – Session set up – Registration – call handling – Re-registration-integrated hybrid architecture to provide ubiquitous services on reconfigurable user terminals Inter-networking with mobile core networks:satellite radio interface standards-Satellite integration with GSM/EDGE – a GERAN approach Satellite integration with UMTS – a UTRAN approach.- Generic IMT-2000 satellite network		**CO4**
UNIT V	**Trends in Mobile Satellite Communication**	**Periods** : **9**
Early proposals of mobile satellite communication-Maresat – Aerosat-Practical limitations – INMARSAT-types and services Pioneering commercial mobile satellite services -Marisat- Marecs -Low earth orbiting mobile satellite communications- Global star and ORBCOMM Non- geo stationary mobile satellite communications- Omni TRACS, Thuraya, Mobile satellite communication services from Intelsat - High altitude platforms –Other important Mobile Satellite Communication Systems –SES, Light squared, Terrestar, Asia Cellular Satellite(ACeS), Mexsat, Google - Military mobile satellite communications.		**CO5**

Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45

Reference Books

1. Ray E. Sheriff and Y. Fun Hu, "Mobile Satellite communication Networks", John Wiley & Sons, 2008.
2. Michael, J.Miller,BrankaVucetic and Les berry, "Satellite Communication: mobile and fixed services", Kluwer Academic Publishers, 2007.
3. M.Richharia, "Mobile Satellite Communications, Principles and Trends", Pearson Education, 2007.
4. StojceDimovIllcev, "Global mobile satellite communication for maritime land and aeronautical Applications"
5. http://w15.easy-share.com/11522731.html.
6. Peter Alfred Swan and Carrie L.Devieux, "Global mobile satellite Systems: A systems overview", 2003.
7.www.britannica.com/EBchecked/topic/524891/satellite-communication
8. www.radio-electronics.com/.../satellite/communications satellite/satellite
9. www.dot.gov.in/data-services/vsat-satellite-communication

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	3	2	1	3	2	3	2	1	1	1	2	2	1
CO2	3	2	3	3	1	1	1	1	2	1	1	2	2	2	3
CO3	2	3	3	3	2	2	3	2	2	2	2	1	2	3	2
CO4	2	3	3	3	2	1	3	1	2	2	1	1	3	3	3
CO5	2	3	3	3	3	1	1	3	2	1	1	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ02	**Free Space Optical Communication**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	Knowledge on fundamentals of FSO and its effects through atmospheric channel
	CO2	Ability to analyze the performance of mitigation and modulation techniques with AWGN channels
	CO3	Knowledge on propagation factors involving different scenarios
	CO4	Knowledge on basis of chaotic and THz wireless communication with free space quantum communication and cryptography
	CO5	Knowledge on advancements of FSO communication

UNIT I	**Fundamentals of Free Space Optics (FSO)**	**Periods** :**9**
Introduction to FSO communication- FSO architectures/topologies- FSO Network implementation – Integrated FSO for satellite, terrestrial and home networks – FSO MANET –Underwater FSO communication-Indoor FSO communication **FSO communication signal propagation through atmospheric channel:** FSO communication in the presence of atmosphere- optical propagation through atmospheric turbulence relevant to FSO communications- PDF models for FSO communication systems		**CO1**
UNIT II	**Modulation, Detection and Coding for FSO**	**Periods** :**9**
FSO communication channel models- AWGN channel, band limited channel, fading and randomly varying optical channel- modulation schemes in FSO communication- on/off keying, PPM and BPSK-channel capacity and coding for FSO communication. **Mitigation techniques for improved system performance:** Mitigation techniques for improved FSO communications -aperture averaging- diversity techniques-spatial diversity- time diversity- coding techniques- adaptive optics techniques		**CO2**
UNIT III	**Non-Line-of-Sight Ultraviolet and Indoor FSO Communication**	**Periods** :**9**
NLOS UV communication- UV communications- source-detector-channel model- performance analysis-indoor FSO system- indoor link configurations- indoor optical wireless system- propagation modeling **Free space optical platforms:** unmanned aerial vehicle FSO communication- UAV scenarios for FSO communication link- alignment and tracking- practical issues and recent development- mobile FSO communication		**CO3**
UNIT IV	**Chaostic and THz Free Space Communications**	**Periods** :**9**
Basics of chaotic optical communication- Chaotic FSO communication over turbulent channel- chaos based secure FSO communication link- indoor THz communication- THz wireless communication. Fundamental of free space quantum communication-quantum cryptography		**CO4**
UNIT V	**Modulating Retroreflector – Based Free Space Optical Communication, Hybrid Optical/Radio Frequency Communication**	**Periods** :**9**
MRR technologies-Description of MRR FSO communication systems-MRR based FSO communication systems performance analysis-Applications-Hybrid optical RF communications-FSOC systems-RF communications systems-Network systems.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Arun K. Majumdar," Advanced Free space optics – A systems approach", Springer, 2015.
2. Heinz Willebrand and Bhaksheesh S. Ghuman, "Free space optics: Enabling optical Connectivity in Today's network", SAMS publishing, 2002.
3. Arun K. Majumdar and Jeniffer Ricklin, "Free space laser communications", Springer, 2008.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2		3	1									2		
CO2	2		3			2	2							3	1
CO3	2		2	1			2							3	
CO4	2	3	2		1									2	
CO5	1		2		3		1						2		

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ03	**Cognitive Radio**	3	-	-	3	40	60	100
Prerequisite	Basics of Digital communication systems and wireless networks.							

Course Outcome	**CO1**	Ability to understand essential background of SDR technologies.
	CO2	Ability to comprehend the cognitive Radio concepts and mapping it to architecture.
	CO3	Ability to understand the importance of spectrum sensing techniques in CR.
	CO4	Ability to understand the different types of spectrum sharing and user cooperative communication.
	CO5	Ability to understand the security issues in CR and apprehend the knowledge with test bed architectures.

UNIT I	**Introduction to Software Defined Radio**	**Periods** :**9**
Definitions and potential benefits, Evolution of software radio architecture, technology tradeoffs and architecture implications. Basic SDR. Hardware Architecture - Block Diagram, Baseband Processor Engines. Software Architecture - Design Philosophies and Patterns, SDR Development and Design-software communication architecture – components, interfaces and application control.		**CO1**
UNIT II	**Cognitive radio Concepts and architecture**	**Periods** :**9**
Cognitive radio – Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, 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.		**CO2**
UNIT III	**Spectrum sensing and identification**	**Periods** :**9**
Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector, Matched Filter ,Cooperative Sensing , Detecting Spectrum Opportunity , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.		**CO3**
UNIT IV	**Spectrum sharing and user cooperative communications**	**Periods** :**9**
Unlicensed Spectrum Sharing - Licensed Spectrum Sharing - Secondary Spectrum Access -Non-Real-Time SSA - Real-Time SSA. User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel.		**CO4**
UNIT V	**Cognitive Radio network security and test bed architectures**	**Periods** :**9**
Cognitive radio network security – Introduction - Primary-User Emulation Attacks- Security Vulnerabilities in IEEE 802.22 - Security Threats to the Radio Software. Test Bed - BERKELEY EMMULATION ENGINE test bed architecture , case study-spectrum sensing.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas Hou, “Cognitive Radio Communications and Networks ,Principles and Practice”, Elsevier 2010.
2. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, “Principles of Cognitive Radio”,Cambridge University Press 2013.
3. Joseph Mitola III, ”Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering”, John Wiley & Sons Ltd. 2000.
4. Hüseyin Arslan ,”Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems” , Springer 2007.

5. Thomas W.Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE .2009.
6. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.
7. Kwang-Cheng Chen,Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons Ltd. 2009.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	3	1	2	2	2	2	1	1	1	2	2	2	2
CO2	3	3	3	3	2	1	3	2	2	3	1	3	3	3	3
CO3	2	2	2	1	2	3	2	1	1	1	1	3	2	2	3
CO4	2	1	2	3	1	2	1	2	1	1	1	2	2	2	1
CO5	3	3	3	3	3	3	2	1	1	2	2	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **First**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ04	**Multimedia Communication Systems**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	Understanding the Basics of Multimedia Communication and Information representation
	CO2	Analysis and Comparison on Text and Image compression
	CO3	Acquiring knowledge on Audio and Video compression and to apply the compression techniques for data storage and communication in Multimedia
	CO4	Ability to understand the different Multimedia Standards and digital representation
	CO5	Understanding the Multimedia communication across different Networks

UNIT I	**Multimedia Communication and Information Representation**	**Periods** : **9**
Multimedia Information Representation-Multimedia Networks-Multimedia Applications, Application and Networking Terminology-Network QoS and Application QoS-Digitization Principles- Text, Images, Audio and Video.		**CO1**
UNIT II	**Text and Image Compression**	**Periods** : **9**
Compression Principles, Text Compression-Runlength, Huffman, LZW, Document Image compression using T2 and T3 coding, image compression- GIF, TIFF and JPEG		**CO2**
UNIT III	**Audio and Video Compression**	**Periods** : **9**
Audio and video compression, audio compression – principles, DPCM, ADPCM, Adaptive and Linear predictive coding, Code-Excited LPC, Perceptual coding, MPEG and Dolby coders video compression, video compression principles.		**CO3**
UNIT IV	**Multimedia Communication Standards**	**Periods** : **9**
MPEG Approach to Multimedia Standardization-MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 Multimedia Framework-ITU-T Standardization of Audiovisual Communication Systems (H.310, H.320, H.321, H.322, H.323, and H.324)-Standards for Audiovisual Services Across ATM H.310 and H.321. Standard H.322		**CO4**
UNIT V	**Multimedia Communications Across Networks.**	**Periods** : **9**
Packet Audio/Video in the Network Environment-Video Transport Across Generic Networks- Layered Compression and Transmission-Requirements Imposed by Streaming Applications- Multimedia Transport Across ATM Networks-Multimedia Across IP Networks. MPEG Video Transmission on the Internet-Digital Television Infrastructure for Interactive Multimedia Services.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Fred Halsall, “Multimedia Communications”, 4th Edition, Pearson education, 2007.
2. Rao K. R., BojkovicZoran S. and Milovanovic Dragorad A, "Multimedia Communication Systems: Techniques, Standard and Networks", PHI, 1st Ed., 2002.
3. Nalin K. Sharda, “Multimedia Information Networking”, PHI, 2002.
4. Rao Kamisetty, BojkovicZoras and Dragorad, "Introduction to Multimedia Communications", Wiley, 1st Ed., 2006.
5. Iain E G Richardson, "H.264 and MPEG-4 Video Compression," John Wiley & Sons, September 2003.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO2	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **First**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ05	**Embedded Systems and RTOS**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Get an insight to the fundamentals and know the general structure of an Embedded System.							
	CO2	Knowledge on the history of real-time operating systems, and acquire knowledge on basic concepts of RTOS such as utility, scheduling and its theories, RTOS characteristics etc.							
	CO3	Examine the operational principle of different scheduling algorithms and their characteristics.							
	CO4	Analyze concepts related to I/O and Memory resources, examine basic problems faced by multi-resource services, and solve challenges faced by soft real time services.							
	CO5	Recognize and resolve software and hardware challenges faced by real-time system to meet service deadlines, and get awareness on embedded system components and debugging components.							

UNIT I	**Typical Embedded System**	**Periods** : **9**
Core of the Embedded System, Embedded Systems Vs General Computing Systems Memory, Sensors and Actuators, Communication Interface, On Board and External Communication Embedded Firmware, Other System Components.		**CO1**
UNIT II	**Introduction to Real-Time Embedded Systems**	**Periods** : **9**
Brief History of Real-Time Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS and its characteristics, Thread Safe Reentrant Functions.		**CO2**
UNIT III	**Processing**	**Periods** : **9**
Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic Least Upper Bound, Necessary and Sufficient Feasibility, Deadline – Monotonic Policy, Dynamic Priority Policies, EDF Algorithm, Multiprocessor Scheduling Algorithms.		**CO3**
UNIT IV	**I/O and Memory Resources**	**Periods** : **9**
I/O Resources: Worst-Case Execution Time, Intermediate I/O, Execution Efficiency, I/O Architecture. **Memory:** Physical Hierarchy, Capacity and Allocation, Shared Memory, ECC Memory: Illustration using Hamming encoding, Flash Fill Systems. **Multi-Resource Services:** Blocking, Deadlock and Livestock, Critical sections to Protect Shared Resources, Priority Inversion and its solutions. **Soft-Real-Time Services:** Missed Deadlines, Quality of Service, Alternatives to Rate Monotonic Policy, Mixed Hard and Soft Real-Time Services.		**CO4**
UNIT V	**Embedded System Components**	**Periods** : **9**
Embedded System Components: Firmware Components, RTOS System Software Mechanisms, Software Application Components. **Debugging Components:** Exceptions, Asserts, Checking Return Codes, Single-Step Debugging, Test Access Ports, Trace Ports, Power-On Self-Test and Diagnostics, Application Level Debugging.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009.
2. James K Peckol, "Embedded Systems - A Contemporary Design Tool", John Wiley, 2008.
3. Sam Siewert, "Real-Time Embedded Systems and Components", Cengage Learning India Edition, 2007.
4. Raj Kamal, "Embedded System- Architecture, programming and Design", 2nd Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
5. C.M. Krishna, Kang G Shin, "Real Time Systems", McGraw-Hill, 1997.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	2	2	2	1	2	1	1	1	1	2	1	1
CO2	3	1	2	2	2	2	1	2	1	1	1	1	2	1	1
CO3	3	3	2	3	3	3	1	2	1	2	1	1	3	3	3
CO4	3	3	2	3	3	3	1	2	1	2	1	2	3	3	3
CO5	3	3	3	3	3	3	1	2	1	2	1	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **First**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ06	**High speed Networks**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	To expose the students to the basic concepts of data transmission in high speed networks							
	CO2	To study the operation of ATM Network							
	CO3	To understand theapplications multimedia networking							
	CO4	To learn the advanced network concepts and Qos in IP networks							
	CO5	To learn the concepts ofhigh performance networking with Wimax and Ultra Wideband							

UNIT I	**Switching and Data Transmission**	**Periods** : **9**
Review of OSI,TCP/IP UDP, multiplexing, modes of communication, routing, Packet-Switching Networks, Frame Relay Networks SONET-DWDM-DSL-ISDN-BISDN. CATV.		**CO1**
UNIT II	**ATM Networks**	**Periods** : **9**
Introduction to ATM; ATM reference model; the ATM layer the ATM adaptation layer (AAL);AAl1;AAL2;AAL3/4;AAL5; traffic classes; traffic management and quality of service; traffic descriptor; traffic shaping; ABR and traffic congestion ;network management; layer management ; ATN signaling; ATM addressing format;; connection establishment; IP/ATM internetworking ; IP multicast over ATM		**CO2**
UNIT III	**Multimedia Networking Application**	**Periods** : **9**
Streaming stored audio and video-best effort service-protocols for real time interactive applications- beyond best effort- scheduling and policing mechanism –integrated services rsvp-differentiated services technology trends in IP networks, internet protocol, IP packet communications in mobile communication networks; intelligent network(in) scheme; comparison with conventional systems; merits of the INscheme;		**CO3**
UNIT IV	**Advanced Networks Concepts and QOS in IP Networks**	**Periods** : **9**
VPN-remote-access VPN ,site-to-site VPN, tunneling to PPP, MPLS-operation, routing, tunneling and, MPLS based VPN , overlay networks-p2p connections.**QOS in ip networks :**Integrated service architecture-queuing discipline -random early detection differentiated services protocol for QOS support- RSVP- multiport Label switching - real time transport protocol- IP version six.		**CO4**
UNIT V	**Wimax and LTE Networks**	**Periods** : **9**
Introduction; Wimax overview; competing technologies; overview of the physical layer; PMP mode; mesh mode; Multi hop relay mode; introduction; time-hopping ultra wideband; direct sequence Ultra wideband; multiband; other types of UWB.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1.Walrand .J. Varaya , "High performance communication network " , Morgan Kaufman Publishers,2nd edition, 2000.

2. Behrouz A. Forouzan, "Data Communications and Networking", Fourth Edition, Tata McGraw Hill.

3. William Stallings, "High Speed Networks and Internets – Performance and Quality of Service", Second Edition, Pearson Education.

4. Kaven Pahlavan And Prashant Krishnamoorthy, "Principles Of Wireless Network", Prentice Hall of India, 2010.

CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO2	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO3	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO4	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO5	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **First**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ07	**Optical Networks**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	To learn the various architectures of optical networks and to introduce the issues and challenges related to optical networks							
	CO2	To understand wavelength routing, wavelength conversion and re-routing in Optical Networks							
	CO3	To understand virtual topology design and construction of optical multicast trees							
	CO4	To expose the students to the concepts of network control and management							
	CO5	To expose the students to the concepts of Optical Packet and Burst Switching and Elastic Optical Network							

UNIT I	**Optical Network Architectures**	**Periods** : **9**
Introduction to WDM optical networks-WDM networks architectures- broadcast and select networks-wavelength routed networks- linear lightwave networks. Issues in wavelength routed networks. Software building blocks for the intelligent optical network and enabling the smart optical network. Future directions in WDM systems and networks		**CO1**
UNIT II	**Routing and Wavelength Assignment**	**Periods** : **9**
Introduction- Classification of RWA algorithms-RWA algorithms-fairness and admission control-distributed control protocols. Optical crossconnects – All - optical, OEO and and hybrid OXCs. Need for wavelength conversion-wavelength convertible node architectures - converter placement on a path. Benefits of wavelength rerouting-issues in wavelength rerouting -rerouting schemes- rerouting in networks with sparse wavelength conversion		**CO2**
UNIT III	**Virtual Topology Design and Optical Multicasting**	**Periods** : **9**
Introduction- virtual topology design problems- virtual topology design subproblems-virtual topology design heuristics-need for virtual topology design reconfiguration. Introduction to multicast routing-multicasting node architectures-multicast tree generation-source based tree generation-Steiner tree based generation- benefits of VS nodes.		**CO3**
UNIT IV	**Network Management and survivability**	**Periods** : **9**
Network management functions- management frame work and protocols -performance management-configuration management- Fault management - protection in SONET/SDH rings –Network survivability and lightpath restoration methods in WDM networks--metrics of evaluation- quality of protection. Optical safety		**CO4**
UNIT V	**Optical Packet and Burst Switching and Elastic Optical Network**	**Periods** : **9**
Introduction to OBS - OBS node architecture- wavelength channel scheduling. Introduction to optical packet switching- node architecture- contention resolution. PON architectures , Elastic Optical Network-Elastic Optical Network elements - Routing and spectrum assignment		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts, Design and Algorithms", Prentice Hall of India, 2011.
2. Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, "Optical Networks: A Practical Perspective", Third Edition, MorganKaufmann Publishers, 2010.
3. Krishna M. Sivalingam and Suresh Subramanian, "Emerging Optical Network Technologies Architectures, Protocols and Performance", Springer, 2005.
4. Neophytos (Neo) Antoniades , Georgios Ellinas and Ioannis Roudas, "WDM Systems and Networks Modeling, Simulation, Design and Engineering", Springer, 2012.
5. Devi Chadha, "Optical WDM Networks: From Static to Elastic Networks", John Wiley & Sons Ltd, 2019.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO2	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO3	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO4	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO5	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **First**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ08	**DSP Architectures**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Develop programs, based on design issues, for fixed-and floating-point DSP processors							
	CO2	Design and develop real-time implementations for DSP algorithms							
	CO3	Implement FFT algorithms in DSP processors							
	CO4	Design and implement digital filters in DSP processors							
	CO5	Design and implement adaptive filters in DSP processors							

UNIT I	**Digital Signal Processing Systems**	**Periods** :**9**
Fundamentals of DSP – Digital Signal Processor Architectures - Software Developments – Hardware Issues – System Considerations – Implementation Considerations. Data Representations, Finite Word Length Effects, Programming Issues, Real-Time Implementation Considerations.		**CO1**
UNIT II	**Fixed- and Floating-Point Digital Signal Processors**	**Periods** :**9**
TMS320C55x – Architecture Overview, Addressing Modes, Instruction Set, Programming Considerations, System Issues. TMS320C62x and TMS320C64x – Architecture Overview, Memory Systems, External Memory Addressing, Instruction Set, Programming Considerations, System Issues. TMS320C67x – Architecture Overview, Instruction Set, Pipeline Architecture, Programming Considerations, Real-Time Implementations.		**CO2**
UNIT III	**Fast Fourier Transform**	**Periods** :**9**
DFT – FFT Algorithms: DIT and DIF – Fixed-Point Implementation using TMS320C64x - Floating-Point Implementation using TMS320C67x.		**CO3**
UNIT IV	**Digital Filters**	**Periods** :**9**
FIR and IIR Filters – Characteristics and Structures. FIR Filter Design using Windowing and Frequency Sampling Techniques. IIR Filter – Butterworth and Chebyshev Filter Design. Fixed-Point Implementation using TMS320C64x - Floating-Point Implementation using TMS320C67x.		**CO4**
UNIT V	**Adaptive Filters**	**Periods** :**9**
Wiener Filter – LMS Filter – Filter Structures – Adaptive Algorithms – Properties and Applications - Fixed-Point Implementation using TMS320C64x - Floating-Point Implementation using TMS320C67x.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Sen M.Kuo, Woon-Seng S.Gan, “Digital Signal Processors: Architectures, Implementations and Applications”, Pearson Education, 2005, Second Impression, 2009.
2. Lapsley et a., “DSP Processor Fundamentals, Architectures and Features”, S.Chand& Co., Reprint, 2000.
3. John G.Proakis and Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Pearson, Fourth Edition, 2007.
4. Monson H.Hayes, “Statistical Signal Processing and Modelling”, Wiley India, 2008.
5. I.C.Ifeachor and B.W.Jervis, “Digital Signal Processing: A Practical Approach”, Pearson, 2002.
6. TMS Manual: TMS320C64xx and TMS320C67xx.

CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	3	2	1	1	3	1	3	3	2	3
CO2	3	3	3	3	3	3	2	1	1	3	1	3	3	2	3
CO3	3	3	3	3	3	3	2	1	1	3	1	3	3	2	3
CO4	3	3	3	3	3	3	2	1	1	3	1	3	3	2	3
CO5	3	3	3	3	3	3	2	1	1	3	1	3	3	2	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ09	**Communication Networks Modeling and Simulation**		3	0	0	3	40	60	100
Prerequisite	Digital communication, wireless networks								
Course Outcome	**CO1**	Ability to understand generation of random numbers and sequences							
	CO2	Ability to understand the estimation and modeling of communication systems.							
	CO3	Ability to apprehend knowledge about the methodology and techniques of simulation.							
	CO4	Capability to impart the network layer modelling in wireless networks							
	CO5	Ability to simulate the GSM and CDMA based cellular system.							

UNIT I	**Generation of Random numbers and Random sequences**	**Periods** : **9**
Random number generation - Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Generating Gaussian random variables. Independent random sequence generation, Correlated Gaussian random sequence generation – scalar and vector case, Correlated Non-Gaussian random sequence. Testing of random number generators.		**CO1**
UNIT II	**Estimation and modeling of communication systems**	**Periods** : **9**
Estimation – Histograms, Power Spectral Density Estimation, Gain, Delay, and Signal-to-Noise Ratios. Memoryless non-linearities – Baseband non-linearities, Bandpass non-linearities – Analytical model and Empirical models. , Non-linearities with memory.		**CO2**
UNIT III	**Simulation methodology and Techniques**	**Periods** : **9**
Mapping a Problem into a Simulation Model , Modeling of Individual Blocks ,Random Process Modeling and Simulation. Monte Carlo Estimation and Integration. Monte Carlo simulation of communication systems – AWGN channel. Semi – Analytic techniques.		**CO3**
UNIT IV	**Layer Modeling of Networks**	**Periods** : **9**
Physical Layer Modeling, Description of the Main Components of the PHY Layer- Physical Layer Modeling for Network Simulations, Medium Access Control (MAC) Protocols, Modeling the Network Layer and Routing Protocols, Components of a Routing Protocol, Metrics.		**CO4**
UNIT V	**Case studies**	**Periods** : **9**
Cellular Radio System - System-Level Description, modeling a Cellular Communication System, Simulation and processing the results. Code-Division Multiple Access System – Methodology, Simulation performance evaluation in terms of Ricean and Rayleigh fading channel.		**CO5**

Lecture Periods: 45	**Tutorial Periods:-**	**Practical Periods: -**	**Total Periods:45**

Reference Books

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

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	3	1	2	3	1	1	2	3	1	3	3	3	3
CO2	2	2	2	3	2	1	2	1	1	2	1	2	2	3	2
CO3	3	2	3	2	2	3	2	2	1	2	1	3	3	2	2
CO4	2	2	3	2	2	2	3	2	2	3	2	3	3	2	3
CO5	3	3	3	3	3	3	2	2	2	3	2	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ10	**Radio Over Fiber Systems**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	To expose the students to the basic concepts of Radio over Fiber systems and basic microwave properties of optical links							
	CO2	To understand the operation of subcarrier optical fiber transmission systems							
	CO3	To learn the components of an RoF system							
	CO4	To understand the applications of RoF technology in cellular communication							
	CO5	To learn the concepts of Fiber Optic Radio Networking							

UNIT I	**Introduction to Radio over Fiber**	**Periods** : **9**
Radio over Fiber systems – concept, categories, performance, applications, advantages and limitations. Microwave properties of optical links, Direct modulated optical links, external modulators, types, modulation transfer in microwave fiber optic links, nonlinearities.		**CO1**
UNIT II	**Analog Fiber Optic Links**	**Periods** : **9**
Sub carrier Optical fiber transmission systems, Fiber optic transmission of 64-QAM, 256- QAM signals, Capacity of coaxial and fiber optic links, LASER diode and Photodiode		**CO2**
UNIT III	**Components for RoF Systems**	**Periods** : **9**
Analog modulation of LASER diode, LASER diode fundamentals, Rate equation analysis, Intensity modulation, Frequency modulation, Low cost LASER diode driver, LASER diode noise and their influence on link performance		**CO3**
UNIT IV	**RoF Technology for the Cellular Applications**	**Periods** : **9**
3G cellular systems, cellular architecture, UMTS architecture, WCDMA RoF systems, Microdiversity, Macro diversity, Traffic estimation, Spectral efficiency, power level, multiple user interference, RoF for Hiper LAN2, Micro cellular communication networks		**CO4**
UNIT V	**Fiber Optic Radio Networking**	**Periods** : **9**
Introduction to radio highway - types of radio highway, Photonic TDMA Highway- Natural sampling of photonic TDMA, Photonic CDMA- Conventional CDMA- DOS- CDMA, Photonic chirp multiple access – architecture and performance, routing networks, chirp multiplexing transform.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Hameed Al-Raweshidy, Shozo Komaki, "Radio over Fiber Technologies for Mobile Communication Networks", Artech House publications, London, 2002.
2. William S. C. Chang, "RF Photonic Technology in Optical Fiber Links", Cambridge University Press,2002.
3. Nathan J. Gomes, Paulo P. Monteiro and Atilio Gameiro, "Next Generation Wireless Communications using Radio over Fiber", John Wiley & Sons, Ltd, 2012.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO2	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO3	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO4	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2
CO5	3	3	3	2	3	2	-	1	1	3	-	3	2	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ11	**Wireless Sensor Networks**		3	-	-	3	40	60	100
Prerequisite	Communication Engineering								
Course Outcome	**CO1**	Knowledgeable in the concept of Sensor network and its protocols for various applications							
	CO2	Familiar with Middleware and Transmission technologies							
	CO3	Skill to observe the challenges in coverage and routing for energy efficiency							
	CO4	Ability to study the possible node architectures for specific applications							
	CO5	Expertise to sense and analyze Global Phenomena							

UNIT I	**Introduction**	**Periods** : **9**
Cellular and Ad hoc wireless Networks – Mobile Ad-Hoc Networks – Sensor Networks – Comparison - Applications –Categories – Issues and challenges in designing a sensor network - Operating environment- Propagation and Propagation Impairments- Architecture – Sensor node technology – Hardware and Software – Performance Metrics – Taxonomy		**CO1**
UNIT II	**Middleware and Transmission Technologies**	**Periods** : **9**
Middleware - Functions – Architecture – Data management functions - **Operating Systems** – Design issues –Examples **Available wireless Technologies** – WSN Campus Applications - Bluetooth – WLAN – Zigbee – WiMax – 3G and beyond - Performance modeling of WSN - Metrics – Task-driven sensing– **Basic models** –Traffic model – Energy model – Node model - **Network models –** MAC model – Routing model – System model		**CO2**
UNIT III	**MAC Protocols for WSN**	**Periods** : **9**
Fundamentals of MAC – Requirements and design constrains – MAC protocols for WSN - Schedule-based protocols -SMAC – LEACH – TRAMA – Contention-based protocols – CSMA – PAMAS **IEEE 802.15.4 standard-Case Study** -PHY layer – MAC layer- Network architecture and types/roles of nodes- Super frame structure -GTS management -Data transfer procedures- Slotted CSMA-CA protocol – Non beaconed mode **Case study of Sensor MAC** - Protocol Overview- Periodic Listen and Sleep Operations -Schedule Selection and Coordination-Schedule Synchronization- Adaptive Listening- Access Control and Data Exchange-Message Passing		**CO3**
UNIT IV	**Routing Protocols and Network Management for WSN**	**Periods** : **9**
Routing Protocols- Challenges and Issues – Data Dissemination and Gathering – Location Discovery - Routing strategies – Flooding and its variants -Gossiping – SPIN – PEGASIS **–** Geographical routing – Localized and globalised forwarding – Greedy perimeter stateless routing - GEAR - **Attribute-based routing** – Direct diffusion – Rumor routing – Geographic hash tables **Network Management** for Wireless Sensor Networks –Requirements-Issues- Naming- Localization		**CO4**
UNIT V	**Transport Protocols and Applications of WSN**	**Periods** : **9**
Transport Protocols -Design Issues – Traditional transport protocols- TCP-UDP-Mobile IP-Feasibility of using TCP/UDP for WSN – Design Considerations – CODA – GARUDA – Performance of Transport Control Protocols. **Applications of WSN- Case Study :** Sensing Global Phenomena – for tracking a moving chemical plume using airborne and ground-based chemical sensors **Case Study :** Simple computation of the System Life Span for a two-tiered topology WSN		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Holger Karl, Andreaswillig, "Protocol and Architecture for Wireless Sensor Networks", John wiley publication, Jan 2006.
2. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks Architectures and Protocols", Prentice Hall, PTR, 2004
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier Publication, 2004.
4. C. K. Toh, "Ad Hoc Mobile Wireless Networks Protocols and Systems", Prentice Hall, PTR, 2001.
5. Charles E. Perkins, "Ad Hoc Networking", Addison Wesley, 2000.
6. Carlos de MoraisCordeiro , Dharma Prakash Agarwal, "Ad hoc and Sensor Network: Theory and Applications", 2nd Edition, World Scientific Publishing Corporation.
7. http://www.ni.com/wsn/
8. http://www.sensor-networks.org/
9. http://www.crcpress.com/
10. Philip Levis, TinyOS Programming, 2006 – www.tinyos.net.

CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	2	3	3	3	1	1	1	1	1	3	2	3
CO2	3	3	2	2	3	3	3	1	2	2	1	1	2	3	2
CO3	3	3	3	3	3	3	3	1	2	1	1	1	2	3	2
CO4	2	2	3	3	3	3	3	1	2	1	1	1	2	2	1
CO5	3	3	3	3	3	3	3	1	2	1	1	1	3	1	1

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ12	**Digital Communication Receivers**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Understand Baseband PAM Communication							
	CO2	Analyze Bandpass Communication over Time Invariant Channels							
	CO3	Study various synchronization techniques							
	CO4	Analyze communication over fading channels							
	CO5	Understand Receiver structure for flat fading and frequency selective fading channel							

UNIT I	**Baseband Communications**	**Periods** : **9**
The Baseband PAM Communication System-Nyquist criterion for eliminating ISI-Clock Synchronizers-Categorization of clock synchronizers-Error Tracking Synchronizers-General structure of Error-Tracking synchronizer-Linearized Equivalent model-Linearized timing error variance-Spectral Line generating Synchronizers-Nonlinearilty followed by a PLL-Nonlinearity followed by a Narrowband BPF.		**CO1**
UNIT II	**Passband Communication over Time Invariant Channels**	**Periods** : **9**
Passband Transmission Methods-Channel and Transceiver Models-Linear and Nonlinear channel model. Receiver Structure for PAM signals-Functional block diagram of a receiver for PAM signal-Timing and Phase recovery. Optimum ML receivers-Receiver objectives and synchronized detection-Optimal ML Receiver for constant Synchronization Parameters-Digital Matched filter.		**CO2**
UNIT III	**Synchronization Techniques**	**Periods** : **9**
Derivation of ML Synchronization algorithms-NDA Timing Parameter Estimation-DA(DD) Timing Parameter Estimators-NDA and DD Carrier phase Estimation-DD and NDA Symbol Synchronizer		**CO3**
UNIT IV	**Communication over fading channels**	**Periods** : **9**
Detection and parameter synchronization on fading channels-Models and synchronization parameters-Optimal Joint detection and Synchronization-Flat fading channels-Selective fading Channels.		**CO4**
UNIT V	**Receiver structure for fading channels**	**Periods** : **9**
Outer and Inner Receiver for fading Channels-Inner receiver for flat fading Channels-Inner receiver for selective fading channels-Recursive computation for the decision metric-ML sequence detection-Reduced Complexity ML sequence Detection. Spread spectrum Communication-Modulator and Demodulator-Synchronization of Pseudo Random signals.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. H.Meyer , M. Moeneclaey, and S. A. Fechtel, “Digital Communication Receivers”, Wiley, 1998.
2. U.Mengali & A.N.D.Andrea, “Synchronization Techniques for Digital Receivers”, Kluwer, 1997.
3. N.Benuveruto & G.Cherubini, “Algorithms for Communication Systems and their Applications”, Wiley, 2002.
4. H.Meyer & G.Ascheid, “Synchronization in Digital Communications”, John Wiley, 1990.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	2	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3
CO3	3	1	2	2	-	-	-	-	-	-	-	-	3	3	3
CO4	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3
CO5	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ13	**Ubiquitous Computing**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Gain knowledge on the essential elements and the challenges in ubiquitous computing							
	CO2	Ability to characterize the wireless LAN in terms of mobility and deployment							
	CO3	Ability to demonstrate the performance of Ubiquotous Computing							
	CO4	Knowledgeable in the types of design in Pervasive communication networks							
	CO5	Develop in understanding ubiquitous computing applications							

UNIT I	**Introduction to Ubiquitous Computing**	**Periods** : **9**
Definition, scope, essential elements of ubiquitous, pervasive, and mobile computing. An introduction, overview, and challenges to research topics in ubiquitous computing, including sensors, ambient displays, tangibles, middleware, mobility, and location and context awareness.		**CO1**
UNIT II	**Architecture for ubiquitous computing**	**Periods** : **9**
New devices and communications; and software architectures. Wireless standards & protocols for ubiquitous networks: Near field communication (NFC), Bluetooth classic, Bluetooth Low Energy (BLE), WiFi, and WiFi Direct.		**CO2**
UNIT III	**Location in ubiquitous computing**	**Periods** : **9**
Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications (Indoor Positioning Techniques). Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture.		**CO3**
UNIT IV	**Ubiquitous applications**	**Periods** : **9**
The appropriate design; Weiser's vision of ubiquitous computing; mixed reality and sensible design. Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper Mobile social networking & crowd sensing, Event based social network.		**CO4**
UNIT V	**Application domains for ubiquitous computing**	**Periods** : **9**
Illustration of some existing application domains for ubiquitous computing in such areas as gaming, workplaces, domestic spaces, museums and educational communities. Human Activity and Emotion Sensing, Health Apps Mobile peer-to-peer (p2p) computing Smart Homes and Intelligent Buildings, Mobile HCI, and Internet of Thinking IoT.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. John Krumm , "Ubiquitous Computing Fundamentals", CRC Press, 2010.
2. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", John Wiley & Sons, 2010.
3. Frank Adelstein, Sandeep, K.S.Gupta, "Fundamentals of Mobile and Pervasive Computing", Tata McGraw Hill, 2009.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	2	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3
CO3	3	1	2	2	-	-	-	-	-	-	-	-	3	3	3
CO4	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3
CO5	3	1	2	3	1	-	-	-	-	-	-	1	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ14	**Reconfigurable Computing**	3	-	-	3	40	60	100
Prerequisite	Nil							

Course Outcome	**CO1**	To explain the basic concept, devices and applications of reconfigurable computing
	CO2	To understand the architecture of FPGA and other reconfigurable logic devices
	CO3	To understand the basic structure of reconfigurable computing systems
	CO4	To give a detailed account on design cycle of reconfigurable computing systems
	CO5	To understand the need and suitability of reconfigurable computing systems for DSP applications

UNIT I	**Introduction to Reconfigurable Computing**	**Periods** : **9**
General Purpose Computing Vs Reconfigurable Computing, Reconfigurable Computing Architectures, Simple Programmable Logic Devices, Complex Programmable Logic Devices,FPGA, Origin of Reconfigurable Computing, apping Algorithms to Hardware, Applications of Reconfigurable Computing		**CO1**
UNIT II	**Reconfigurable Logic Devices**	**Periods** : **9**
Field-Programmable Gate Arrays - Basic Architecture, Specialized Function Blocks, Programming Architecture; Coarse-Grained Reconfigurable Arrays – Raw, PipeRench, RaPiD, PACT XPP, MathStar		**CO2**
UNIT III	**Reconfigurable Computing Systems**	**Periods** : **9**
Parallel Processing on Reconfigurable Computers, Instruction Level Parallelism, Task Level Parallelism, A Survey of Reconfigurable Computing Systems, I/O Bus, Accelerator, Massively Parallel FPGA array, Reconfigurable Supercomputer, Reconfigurable Logic Co-processor		**CO3**
UNIT IV	**Languages and Compilation**	**Periods** : **9**
Design Cycle; Languages - Algorithmic RC Languages, Hardware Description Languages (HDL);High Level Compilation -Compiler Phases, Analysis and Optimizations, Scheduling; Low Level Design Flow - Logic Synthesis, Technology Mapping, Logic Placement, Signal Routing, Configuration Bitstreams; Debugging Reconfigurable Computing Applications-Basic Needs for Debugging, Debugging Facilities, Challenges for RC Application Debugging.		**CO4**
UNIT V	**Signal Processing Applications**	**Periods** : **9**
Overview to Digital Signal Processing; Reconfigurable Computing for DSP; Building blocks of DSP applications - Basic Operations and Elements Filtering Transforms; Example DSP Applications –Beam forming, Software Radio		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Maya B. Gokhale and Paul S. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
2. Scott Hauck and Andre Dehon (Eds.), “Reconfigurable Computing – The Theory and Practice of FPGA Based Computation”, Elsevier, Morgan Kaufmann, 2008.
3. Christophe Bobda, “Introduction to Reconfigurable Computing – Architectures, Algorithms and Applications”, Springer, 2010.

CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	**3**		**2**		**1**										
CO2	**3**		**2**		**1**										
CO3	**3**		**2**		**1**										
CO4	**3**		**2**		**1**										
CO5	**3**		**2**		**1**										

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ15	**Cryptography and Network Security**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	Understanding the Basics of Cryptography, Symmetric Ciphering Techniques and Algorithms
	CO2	Knowledge on Number Theory and Public Key Cryptosystems with the ability to design and develop cryptography algorithms
	CO3	Developing the capability of designing and implementing Integrity and Authentication protocols for Data Security
	CO4	Knowledge on Network and Internet Security and to implement and practice for real time applications
	CO5	Design and Implementation of System Security with ethical principles and social responsibilities

UNIT I	**Introduction and Symmetric Key Cryptography**	**Periods** : **9**
Attacks-Services-Mechanisms-OSI Security architecture-Network Security and Symmetric Cipher Model-Substitution and Transposition Techniques-DESAlgorithm-Differential and Linear Cryptanalysis-Groups,Rings and Fields-Modular Arithmetic-Euclidean Algorithm- Finite Fields of the Form GF(p) and GF(2^n)-Polynomial Arithmetic-AES Cipher-Block Cipher Modes of Operation- Multiple Encryption.		**CO1**
UNIT II	**Number Theory and Public Key Cryptography**	**Periods** : **9**
Prime Numbers-Fermat's and Euler's Theorems-Testing forPrimality-The Chinese Remainder Theorem-Discrete Logarithms-Principles of Public Key Cryptosystems-The RSA Algorithm-Key Distribution-Key Management-Diffie-Hellman KeyExchange-ElGamal Cryptosystem--Elliptic Curve Arithmetic- Elliptic Curve Cryptography.		**CO2**
UNIT III	**Data Integrity and Authentication Schemes**	**Periods** : **9**
Authentication Requirements-Authentication functions-Message Authentication Codes-Hash Functions-Security of MAC and Hash Functions-Message Digest Algorithm (MD5)-Secure Hash Algorithm (SHA)-HMAC-CMAC-Digital Signatures-Digital Signature Standard- Authentication Protocols-Kerberos-X.509 Authentication Service.		**CO3**
UNIT IV	**Network and Internet Security**	**Periods** : **9**
Web Security Issues-Secure Sockets Layer (SSL) and Transport Layer Security (TLS)-HTTPS-Secure Shell (SSH)-Secure Electronic Transaction (SET)-Wireless Network Security-IEEE 802.11i Wireless LAN Security-Electronic Mail Security-Pretty Good Privacy-S/MIME-IP-Security Overview-IPSecurity Architecture-Authentication Header-Encapsulation Security Payload.		**CO4**
UNIT V	**System Security, Legal and Ethical Issues**	**Periods** : **9**
Intruders-Intrusion Detection-Password Management-Types of Malicious Software-Viruses-Virus Countermeasures-Distributed Denial of Service Attacks-Firewall Design Principles-Types of Firewalls-Firewalls Configurations-Trusted Systems-Cybercrime and Computer Crime-Intellectual Property-Privacy-Ethical Issues		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. William Stallings, "Cryptography and Network Security-Principles and Practice", 7th Edition, Pearson Education Limited, 2017.
2. Douglas Stinson, "Cryptography, Theory and Practice", Fourth Edition, Taylor and Francis Group, 2019.
3. Michael E.Whitman and Herbert J.Mattord, "Principles of Information security", 3rd edition, 2009.
4. Bruce Schneier, "Applied Cryptography, Protocols, Algorithms and Source code in C", 2nd Edition, John Wiley & Sons, 2006.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Second**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ16	**Speech and Audio Signal Processing**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Knowledgeable in speech production mechanism and nature of speech signal							
	CO2	Ability to characterize the time domain methods for speech analysis							
	CO3	Ability to characterize the frequency domain methods for speech analysis							
	CO4	Ability to formulate the speech predictive models by estimating the speech parameters							
	CO5	Ability to build an automatic speech recognition system							

UNIT I	**Digital Models for Speech Signal**	**Periods** : **9**
Speech signal - Applications of digital speech processing - mechanism of speech production- acoustic theory of speech production- lossless tube models – digital models for speech signals.		**CO1**
UNIT II	**Time Domain Models for Speech Processing**	**Periods** : **9**
Time dependent processing of speech - Short- time energy and zero-crossing rate – Short time autocorrelation function (STACF)– pitch period estimation- digital representation of speech waveform - sampling and quantization – adaptive quantization – delta modulation and differential PCM		**CO2**
UNIT III	**Short Time Fourier Analysis**	**Periods** : **9**
Fourier transform interpretation – linear filtering interpretation – filter bank summation method – design of digital filter banks – pitch detection.		**CO3**
UNIT IV	**Linear Predictive Analysis**	**Periods** : **9**
Basic principles – computation of gain for the model – solution of LPC equations – prediction error signal – frequency domain interpretation of LP analysis – comparison to other spectrum analysis methods		**CO4**
UNIT V	**Homomorphic Speech Processing and ASR**	**Periods** : **9**
Short time cepstrum – computation of cepstrum – short time homomorphic filtering of speech – Application to pitch detection – Formant Estimation – Homomorphic Vocoder – Automatic Speech Recognition – Building a speech recognition system – decision process in ASR – challenges.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Rabiner and Schafer, “Digital Processing of speech signal”, fourth edition, Pearson, 2009.
2. L.R. Rabiner and R.WSchafer, “Introduction to Digital speech processing”, Prentice Hall, 2007.
3. Jacob Benesty, M. M. Sondhi, Yiteng Huang, “Springer handbook of Speech Processing”, Springer, 2008.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO2	3	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO3	3	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO4	3	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO5	3	3	3	3	3	3	3	3	1	1	1	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Third**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
ECZ17	**Pattern recognition and Machine learning**	3	-	-	3	40	60	100
Prerequisite	Probability and Stochastic Process							
Course Outcome	**CO1**	Understand the fundamentals of learning algorithms and pattern recognition						
	CO2	Know the major approaches in statistical and syntactic pattern recognition						
	CO3	Become aware of the theoretical issues involved in pattern recognition system						
	CO4	Apply the concept of non-parametric techniques for pattern classification						
	CO5	Develop applications using different machine learning techniques						

UNIT I	**Mathematical Fundamentals for Pattern Recognition and Machine Learning**	**Periods**:**9**
Introduction to Probability Theory, Decision Theory and Information Theory, Concepts of learning, Supervised and unsupervised learning, Curse of dimensionality, Probability distributions, Parametric and Non-parametric methods, Gaussian distribution, Maximum- Likelihood estimation, Bayesian inference, Mixture of Gaussians, Nearest-neighbor methods.		**CO1**
UNIT II	**Introduction to Pattern Recognition**	**Periods**:**9**
Introduction to Pattern Recognition, Design Cycle of Pattern Recognition System, Bayesian Decision Theory –Continuous Features, Two category classification, classifiers, Discriminant Functions and decision Surface, Multi category case, two category case.		**CO2**
UNIT III	**Component Analysis & Discriminants**	**Periods**:**9**
Component Analysis and Discriminants – Principle component analysis, Fisher Linear Discriminant, Multiple Discriminant Analysis. Hidden Markov Models- First Order, First Order HMM, HMM Computation, Evaluation, Decoding, Learning.		**CO3**
UNIT IV	**Non parametric Pattern Recognition Techniques**	**Periods**:**9**
Non-parametric techniques: density estimation, Parzen Windows, K_n-Nearest Neighbor estimation, Non-metric methods for pattern classification - Non-numeric data ornominal data, Decision trees, Random forest algorithm.		**CO4**
UNIT V	**Machine Learning Algorithms**	**Periods**:**9**
Linear models for regression and classification, Perceptron, Artificial Neural networks, Support Vector Machines, Unsupervised learning, Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, First Edition, Springer Publication,2006.
2. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, Second Edition, John Wiley, 2000.
3. Tou,Gonzalves, “Pattern recognition Principles”,Second Edition, Addison Wesley Longman Publishing, 1974.
4. Tom Mitchell, “Machine Learning”, First Edition, McGraw-Hill, 2017.
5. Keinosuke Fukunaga, “Introduction to Statistical Pattern Recognition”, Second Edition, Academic Press, 2013.
6. Andrew R. Webb, “Statistical pattern recognition”, Third Edition, Wiley publishers, 2011.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	1	3	3	3		1	2		2	1	3	2
CO2	2	2	3	2	2	1	2		1	2		2	1	2	3
CO3	2	2	3	2	2	2	2		1	2		2	3	2	3
CO4	3	2	2	1	1	2	2		2	3		2	3	2	2
CO5	3	2	2	1	2	3	1		1	3		2	2	2	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering & Wireless Communication)**						
Semester: **Third**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name:		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
ECZ18	**Digital Image & Video Processing**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome	**CO1**	Understand the fundamentals of Image and Video processing							
	CO2	Learn different techniques for image and video enhancement and recovery							
	CO3	Gain knowledge of techniques for image and video segmentation							
	CO4	Study techniques for image and video compression							
	CO5	Examine the use of image descriptors and pattern classifiers							

UNIT I	**Digital Image and Video Fundamentals**	**Periods** : **9**
Types of Images , Scale of Images, Dimension of Images - Digitization of Images , Sampled Images, Quantized Images, Color Images, Size of Image Data . Digital Video, Sampled Video and Video Transmission. Image and Video acquisition - Image Scanning, Sampling, and Interpolation Video Sampling and Interpolation		**CO1**
UNIT II	**Image & Video Enhancement and Restoration**	**Periods** : **9**
Image Histogram, Linear Point and Nonlinear point operations on images, Arithmetic and Geometric image operations, Basic linear filtering and nonlinear filtering for image analysis and enhancement. Basic Methods for Image Restoration and Identification - Blur Models -Image Restoration Algorithms. Motion Estimation -Motion Models, Estimation Criteria , Search Strategies - Video enhancement and restoration		**CO2**
UNIT III	**Image and Video Segmentation**	**Periods** : **9**
Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Use of motion in segmentation Video segmentation - Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation.		**CO3**
UNIT IV	**Image and Video Compression**	**Periods** : **9**
Basics of Lossless image coding, Lossless symbol coding - Lossy image Compression - Block Truncation coding Concepts and Techniques of Video Coding **- In**ternational standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.261)		**CO4**
UNIT V	**Feature extraction and Pattern classification**	**Periods** : **9**
Image Feature representation and description-boundary representation, boundary descriptors, regional descriptors. Pattern and Pattern classes - minimum distance and Bayes classifier		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Ed. Al Bovik , "Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000.
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 3rd Edition, Prentice Hall, 2008.
3. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding", 2nd Edition, Academic Press, 2011.
4. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015.
5. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	1	1	1	1	1	1	2	2	1	1	1	1	1
CO2	2	3	3	3	3	3	2	1	2	2	1	2	2	2	2
CO3	2	3	3	3	3	3	2	1	2	2	1	2	2	2	2
CO4	2	3	3	3	3	3	2	1	2	2	1	2	2	2	2
CO5	2	3	3	3	3	3	2	1	2	2	1	2	2	2	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Third**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	15	CA	SE	TM
ECZ19	**Audio Coding and Compression**		3	-	-	3	40	60	100
Prerequisite	Digital communication and Signal processing								
Course Outcome	**CO1**	Acquire knowledge on the basics of audio coding							
	CO2	Understand the role of filter banks in audio coding systems							
	CO3	Understand the heuristic models and tools used in the aid of audio coding							
	CO4	Gain an in=depth understanding of perceptual audio coders							
	CO5	Thoroughly understand about the various audio compression techniques							

UNIT I	**Introduction to the Fundamentals of Audio Coding**	**Periods** : **9**
Definition and classification of audio signals -Representation of audio signals in time domain- Need for quantisation -Audio coder definition and basics – design factors : fidelity, data rate, complexity and delay -simple PCM encoder- potential coding errors: sampling error , Quantisation error: overload error and round-off error –Entropy coding - Need for transform domain representation - Properties of audio signals -Representation of signals in frequency domain		**CO1**
UNIT II	**Frequency Mapping of Audio Signals**	**Periods** : **9**
Basics of filter banks -Two-Channel Perfect Reconstruction Filter Banks -The Pseudo-QMF Filter Bank-Perfect reconstruction transform encoder using DFT and modified DCT- matrix derivation of time domain aliasing cancellation – MDCT implementation via FFT – Comparison of MDCT and PQMF filter banks		**CO2**
UNIT III	**Psychoacoustic Models for Audio Coding**	**Periods** : **9**
Basics of psychoacoustics-The Masking Phenomenon : Frequency masking , Temporal masking - Measuring Masking Curves -Critical Bandwidths- Excitation patterns and masking models -Excitation Patterns and Masking Models -The Bark Scale Models for the Spreading of Masking Masking Curves "Addition" of Masking Modeling the Effects of Non-Simultaneous (Temporal)Masking . Perceptual Entropy . Masked Thresholds and Allocation of the Bit Pool		**CO3**
UNIT IV	**Perceptual Audio Codecs**	**Periods** : **9**
Overview of the Coder Building Blocks -Computing Masking Curves- Bitstream Format-Quality measurements of perceptual audio codecs - Objective perceptual measurements of audio quality-overview of audio coding standards for compression		**CO4**
UNIT V	**Audio Compression**	**Periods** : **9**
Audio compression techniques - μ- Law and A- Law companding– ADPCM compression - G.726 ADPCM -MPEG/audio compression -Basic sub-band coding — progressive encoding for audio – Silence compression,– vocoders : channel vocoder, Formant vocoder, LPC - CELP Vocoders		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. https://www.researchgate.net/publication/239700340_Audio_Signal_Classification.
2. Marina E. Bosi and Richard E.Goldberg, "Introduction to Digital Audio Coding and Standards", Springer Science and Business Media LLC, 2003.
3. http://brahms.emu.edu.tr/babagil/10comp306Basic%20Audio%20Compression%20Techniques.pdf
4. Davis Yen Pan, "Digital Audio Compression", Digital Technical Journal, Vol 5, No.2, pp: 1 to 14 ,June 1993.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	3	3	2	3	3	3	2	1	2	3	3	2
CO2	3	3	2	3	3	3	2	3	3	3	1	3	3	3	2
CO3	3	3	2	3	3	2	3	2	2	3	1	3	3	2	2
CO4	3	3	2	3	3	3	3	3	2	3	1	3	3	2	2
CO5	3	3	2	3	3	3	3	2	3	3	1	3	3	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Electronics and Communication Engineering)**						
Semester: **Third**		Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	15	CA	SE	TM
ECZ20	**Optimization Techniques**	3	-	-	3	40	60	100
Prerequisite	Analytical skills equipped with the ability to apply mathematical understanding to optimization techniques							
Course Outcome	**CO1**	Acquire a broad picture of optimization techniques						
	CO2	Acquire knowledge on various linear programming methods						
	CO3	Understand about different non-linear programming methods						
	CO4	Able to apply dynamic programming techniques to the optimization of multistage decision problems						
	CO5	Acquire knowledge on advanced topics in optimization techniques						

UNIT I	**Introduction to Optimization**	**Periods** : **9**
Historical Development; Engineering applications of Optimization; Art of Modeling - Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems -Classification of optimization problems -Optimization techniques – overview of classical and advanced techniques		**CO1**
UNIT II	**Linear Programming**	**Periods** : **9**
Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm. Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.		**CO2**
UNIT III	**Non-Linear Programming**	**Periods** : **9**
Classification of Non Linear programming – Lagrange multiplier method – Karush – Kuhn Tucker conditions–Reduced gradient algorithms–Quadratic programming method – Penalty and Barrier method.		**CO3**
UNIT IV	**Dynamic Programming**	**Periods** : **9**
Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution – examples illustrating the tabular method of solution.		**CO4**
UNIT V	**Advanced Topics in Optimization**	**Periods** : **9**
Piecewise linear approximation of a nonlinear function Multi objective optimization – Weighted and constrained methods; Multi level optimization Direct and indirect search methods -Evolutionary algorithms for optimization and search		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. https://www.researchgate.net/profile/Abbas_Abd/publication/282734511_Engineering_Optimization
2. Singiresu S. Rao, "Engineering Optimization: Theory and Practice", John Wiley and Sons, 4th edition, 2009.
3. Edwin K.P.Chong and StainslawH.Zak, "An introduction to optimization", John Wiley and Sons, Second edition, 2001.
4. Rajesh Kumar Arora, "Optimisation Algorithms and Applications", CRC Press, 2015.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	3	3	2	3	3	3	2	1	2	3	3	2
CO2	3	3	2	3	3	3	2	3	3	3	1	3	3	3	2
CO3	3	3	2	3	3	2	3	2	2	3	1	3	3	2	2
CO4	3	3	2	3	3	3	3	3	2	3	1	3	3	2	2
CO5	3	3	2	3	3	3	3	2	3	3	1	3	3	3	2

Score: **3** – High; **2** – Medium; **1** – Low