PUDUCHERRY TECHNOLOGICAL UNIVERSITY
PUDUCHERRY–605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi

For

M.Tech in Wireless Communication

(With effect from Academic year 2020-21)

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

CURRICULUM

The curriculum of M.Tech (Wireless Communication) 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 Wireless Communication.
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 area of Wireless Communication.
PO2	Ability to be innovative and develop aptitude for independent research and development.
PO3	Ability to demonstrate a degree of mastery in the area of Wireless Communication .
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 Wireless Communication Systems using Communication & Networking Platforms tools.
PSO2	Explore evolving technologies in Wireless Communication, Advanced Radiating Systems, Mobile, Optical and Satellite Communication and Wireless Communication Standards.
PSO3	Ability to understand and use contemporary Software tools for Modelling, Design, and Analysis of Wireless 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
EC262	Advanced Signal Processing and Communication 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	
EC263	Wireless Communication Systems	**PCC**	3	0	0	3
EC256	Advanced Radiating Systems	**PCC**	3	0	0	3
EC264	CDMA and OFDM for Multiuser Communication	**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
EC265	Wireless Communication Laboratory	**PCC**	0	0	4	2
EC266	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
EC267	Dissertation – Phase I	**PAC**	0	0	20	10
Total			**26**			**16**

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EC268	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 (WC)	
I sem	**PSE - 1**	**ECZ01**	Mobile Satellite Communication
		ECZ02	Free Space Optical Communication
		ECZ03	Cognitive Radio
		ECZ04	Multimedia Communication Systems
I sem	**PSE -2**	**ECZ21**	Emerging Wireless Technologies
		ECZ22	Programmable networks
		ECZ23	Ultra Wideband communications
		ECZ24	Mobile data management
II sem	**PSE -3**	**ECZ09**	Communication Networks Modeling and Simulation
		ECZ10	Radio over Fibre systems
		ECZ11	Wireless Sensor Networks
		ECZ12	Digital Communication Receivers
II sem	**PSE - 4**	**ECZ25**	Space time wireless communications
		ECZ26	Internet of things
		ECZ27	Information Security
		ECZ28	Advanced MIMO
III sem	**PSE - 5**	**ECZ29**	VLSI for Wireless Communication
		ECZ18	Digital Image & Video Processing
		ECZ30	AI for wireless communication
		ECZ31	Wireless Body Area Networks

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 memory less 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	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 Non-stationary 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**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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.(Wireless Communication)**						
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
EC262	**Advanced Signal Processing and Communication Laboratory**		-	-	4	2	40	60	100
Prerequisite									
Course Outcome	**CO1**	Design and Analyze the performance of digital modulation scheme in various wireless channels.							
	CO2	Implement Error control codes and Establish wireless Networks.							
	CO3	Understand Signal and Image processing.							

List of Experiments :	
1. Design of GMSK modulator for GSM system. 2. Designing Yagi antenna and study the Return loss magnitude and phase characteristics. 3. Design and analysis of digital modulation techniques in various channels on an SDR platform. 4. Carrier and Symbol timing Synchronization using SDR platform.	**CO1**
5. Study of error detection and correction codes using MATLAB Simulink or equivalent software. 6. Developing any one network topology and establishing a routing protocol. 7. Call establishment using different entities of GSM network. 8. Study of wireless sensor network. 9. Study of satellite link design. 10. Study of optical link design.	**CO2**
11. Implementation of FFT of real time input signals using DSP trainer kits. 12. Design and implementation of digital filter for speech coding. 13. Analyze Image Compression using MATLAB or equivalent software. 14. Analyze data/Image security using MATLAB or equivalent software.	**C03**

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

Reference Books

1. John G. Proakis and MasoudSalehi, "Digital Communications", 5th edition, Tata McGraw Hill, 2008.
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Fourth Edition, Prentice Hall of India, New Delhi, 2007.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	3	2	3	2	1	1	2	1	2	3	3	3
CO2	3	3	3	3	2	3	2	1	1	2	1	2	3	3	3
CO3	3	3	3	3	2	3	2	1	1	2	1	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: **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	PO10	PO11	PO12	PSO1	PSO2	PSO3
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.(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
EC263	**Wireless Communication Systems**	3	-	-	3	40	60	100
Prerequisite	Communication Fundamentals, Digital Communication							

Course Outcome	**CO1**	Understanding the practical application of wireless communication in real-time networks and Ability to track the growth trend of the Wireless Communication Systems.
	CO2	Ability to Characterize the wireless channel statistically and measure channel parameters quantitatively.
	CO3	Acquiring the capability to apply and compare Diversity and equalization techniques and to employ MIMO concepts in design of advanced wireless systems.
	CO4	Ability to identify and design suitable antennas fitting the requirements of wireless device/applications.
	CO5	Knowledge to determine the BER performance of digital modulation schemes and to perform capacity analysis in fading environment.

UNIT I	**Emerging Wireless trends**	**Periods** : **9**
UMTS-WCDMA, CDMA-2000 network. LTE and LTE–A systems- Multi-Carrier Modulation concept: Data transmission with multiple carriers, Implementation of multicarrier, Challenges in Multicarrier systems- Multicarrier modulation with overlapping sub channels, Mitigation of subcarrier fading. 5G systems – System concept, IoT in 5G, Review on Machine Type Communications, D2D Communications, 5G Access Technologies, mm wave communications.		**CO1**
UNIT II	**Wireless Channel Characterization**	**Periods** : **9**
Review on wireless channels – Propogation effects and shadowing, Channel behaviour, statistical Characterization using Rayleigh, Rice, Nakagami –m and other distributions – Second order fast fading statistics, Narrowband mobile radio channel simulations. Wideband Fading: Effects, Channel model and parameters, frequency domain effects. Channel measurements for mobile Systems: Impact of measurement inaccuracy, Measurement systems, outdoor and indoor measurements.		**CO2**
UNIT III	**Signal Processing Techniques**	**Periods** : **9**
Diversity – Types, Micro and Macro diversity, Transmit Diversity with and without Channel state Information. Diversity combining techniques. Introduction to MIMO Wireless Communications, MIMO System Model, SVD of MIMO, MIMO Capacity Analysis for static and fading channels. Introduction to Multiuser MIMO. Channel estimation and equalization: Blind and adaptive concept. Equalization (qualitative treatment only)– Linear, Non-Linear and Adaptive equalization, Zero forcing and LMS Algorithms. Introduction to Cooperative and Coordinated Transmissions : CoMP.		**CO3**
UNIT IV	**Antennas for wireless communications**	**Periods** : **9**
Mobile terminal Antennas: Performance requirements-Dipoles- Helical- inverted F, patches- MEG-SAR-Mobile satellite Antennas. Base station antennas: Performance requirements in macro cell- antenna design and diversity- micro/pico cell antennas, WLAN antennas. Adaptive antennas: Adaptive antenna applications- optimum combining- MIMO systems- impact of antennas on MIMO performance, Massive MIMO and beam forming.		**CO4**

UNIT V	Performance and Capacity Analysis		Periods : 9
Demodulator structure, error probability in AWGN channels, Error Probability in flat fading channels, Error Probability in Delay and Frequency Dispersive fading Channels. Error probability of fading channels with diversity reception. Capacity Analysis: Capacity of Flat fading Channels, Channel and system model, Channel State Information at transmitter and receiver, Capacity of frequency selective fading Channels.			CO5
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Reference Books

1. Andreas F. Molisch, "Wireless Communications", Publisher: Wiley, second edition, 2011.
2. Ke-Lin Du And M. N. S. Swamy, "Wireless Communication Systems From RF Subsystems to 4G Enabling Technologies", Cambridge University Press, 2007.
3. Simon R. Saunders, Alejandro Arago, N-Zavala, "Antennas And Propagation For Wireless Communication Systems", Second Edition, John Wiley and sons, 2007.
4. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.
5. AfifOsseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
6. Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis (Takis) Mathiopoulos, "New Directions in Wireless Communications Systems: From Mobile to 5G", CRC Press, 2018.

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	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	2	2	3	1	3	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
CO4	3	3	3	3	3	3	3	3	3	2	1	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	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: **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.(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
EC264	**CDMA and OFDM for multiuser communication**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	**CO1**	Understand the fundamentals of OFDM							
	CO2	Analyze the performance of OFDM with frequency/timing errors and Adaptive modulation							
	CO3	Estimate the channel and understand detection techniques							
	CO4	Understand the principle of CDMA							
	CO5	Analyze the performance of OFDM & MC-CDMA							

UNIT I	**Fundamentals of OFDM**	**Periods** : **9**
Introduction-Principles of QAM-OFDM-Modulation by DFT-Transmission via band limited channels-Generalized Nyquist Criterion-Basic OFDM Implementations-Cyclic OFDM Symbol Extension-OFDM Bandwidth Efficiency-Choice of the OFDM Modulation. OFDM system performance over AWGN channels-OFDM transmission over UMTS type channel-Inter subcarrier Interference cancellation.		**CO1**
UNIT II	**OFDM Synchronization and Modulation**	**Periods** : **9**
Performance with frequency and timing errors-Synchronization Algorithms-Synchronization using pilots. Motivations for Adaptive modulation -Adaptive techniques-channel quality estimation-parameter adaptation-Signalling the AOFDM parameters. Multiuser AOFDM-Adaptive transceiver architecture-Simulation results with perfect channel knowledge-Pilot-based channel parameter estimation.		**CO2**
UNIT III	**Channel Estimation and detection for multiuser OFDM system**	**Periods** : **9**
Channel Estimation : LS Error Decision-Directed Channel Estimation-Derivation of the LS-Estimator, Frequency Domain Parallel interference Cancellation Aided DDCE-The Recursive Channel Estimator. Detection Techniques: Linear Detection Techniques-Least-Squares error Detector-Minimum Mean-Square Error Detector. Non Linear Detection Techniques-Standard SIC, MSIC and its Derivatives, PIC Detection.		**CO3**
UNIT IV	**Principles of Code Division Multiple Access**	**Periods** : **9**
Spread spectrum technique – Direct sequence and frequency hopping spread spectrum communication system – PN codes and Walsh codes – Rake receiver – Capacity – Effects of loading, sectorization and voice activity – Power control – Hand off – Link structure – Forward link – Pilot, synchronization, paging and traffic channels – Reverse Link – access and traffic channel.		**CO4**
UNIT V	**OFDM Vs MC-CDMA Systems**	**Periods** : **9**
Amalgamating DS-CDMA and OFDM-Multicarrier CDMA-MC-CDMA Performance in Synchronous environments. Adaptive modulation for OFDM and MC-CDMA-System description-General model-five mode AQAM-Seven-Mode Adaptive Star-QAM-Five mode APSK-Ten-mode AQAM. Applications of MC-CDMA in LTE and IOT.		**CO5**

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

Reference Books

1. L.Hanzo, M.Munster, B.J.Choi and T.Keller, "OFDM and MC-CDMA for Broadband Multi-User Communications, WLANs and Broadcasting", John Wiley & Sons, 2003.
2. Rohling, Hermann (Editor), "OFDM Concepts for Future Communications", Springer, 2011.
3. Ahmad RS Bahai, Burton R.Saltzberg and Mustafa Erge, "Multicarrier Digital Communications: Theory and Applications of OFDM", Springer Newyork, 2004.
4. Samuel C Yang, "CDMA RF System Engineering", Artech House, 1998.
5. Richard Van Nee and Ramjee Prasad, "OFDM for wireless Multimedia Communication", Artech House, 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	1	1	2	2	2	-	-	-	-	-	-	3	3	1
CO2	3	2	1	3	2	3	-	-	-	-	-	-	3	3	3
CO3	3	2	1	3	2	2	-	-	-	-	-	-	3	3	3
CO4	3	1	1	3	2	2	-	-	-	-	-	-	3	3	3
CO5	3	1	1	2	2	3	-	-	-	-	-	-	3	3	3

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

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(Wireless Communication)**						
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
EC265	**Wireless Communication Laboratory**	-	-	4	2	40	60	100
Prerequisite	Wireless Communication fundamentals							

Course Outcome	**CO1**	Capability to handle advanced wireless system hardware units like CDMA/OFDM and Biosensor modules. Ability to design and implement any type of filter in real-time with FPGA kits.
	CO2	Ability to design and test the required mobile and base station antennas for different mobile generations.
	CO3	Ability to Characterize the wireless channel statistically and measure channel parameters quantitatively.

List of Experiments :

1. Perform the CDMA system performance study with the test bed. 2. Perform the OFDM system performance study with the test bed. 3. Using the Spartan6 FPGA, design and implement an equalizer circuit for a fading channel and test its performance. 4. Performance study of medical data analysis using biomedical sensors NI Labview / equivalent.	**CO1**
5. Design various mobile station antennas and determine the antenna parameters. 6. Design various Base station antennas and determine their performance parameters. 7. Obtain the radiation characteristics of the horn, reflector and array antennas.	**CO2**
8. Through simulations, obtain the BER performance of MIMO systems with varying diversity order and compare it with SIMO and MISO. 9. Comparative analysis of various propagation and fading models. 10. Invoking a UMTS Call establishment process through simulations. 11. Compare the capacity obtained for a MIMO system fading scenario with and without the channel knowledge known to the transmitter.	**CO3**

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

Reference Books

1. Andreas F. Molisch, "Wireless Communications", Wiley, second edition, 2011.
2. Ke-Lin Du And M. N. S. Swamy, "Wireless Communication Systems From RF Subsystems to 4G Enabling Technologies", Cambridge University Press, 2007.
3. Simon R. Saunders, Alejandro Arago, N-Zavala, "Antennas And Propagation For Wireless Communication Systems", Second Edition, John Wiley and sons, 2007.

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	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	2	1	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3

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

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(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
EC266	**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**	**PO10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
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.(Wireless Communication)</td></tr>
<tr><td colspan="4">Semester: Third</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>EC267</td><td>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	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

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(Wireless Communication)**						
Semester: **Fourth**			Course Category Code: **PAC**				Semester Exam Type: **PR**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P		CA	SE	TM
EC268	**Dissertation – Phase II**		-	-	32	16	250	250	500
Prerequisite	-								
Course Outcome	**CO1**	Ability to transform knowledge into an experimental process							
	CO2	Ability to demonstrate the motivation to extend the work to a research							
	CO3	Ability to identify and apply appropriate tools to solve a problem and also has the capability to examine hypotheses							
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.									**CO1, CO2, CO3**
Lecture Periods: -	**Tutorial Periods: -**		**Practical Periods: 480**				**Total Periods: 480**		

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	**Chaotic 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 Todays 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, 2003.

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	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.(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
ECZ21	**Emerging Wireless Technologies**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome		
	CO1	To understand the basic concept of Emerging Technologies
	CO2	To gain the knowledge on LTE and 5G technology
	CO3	To learn the femtocell technology
	CO4	To expose the students to the concepts of Intelligent Autonomous Communications
	CO5	To acquire knowledge about smart devices and content delivery Network

UNIT I	**Emerging Technologies**	**Periods** : **9**
Bluetooth –Radio frequency Identification – Wireless Broadband (WiMax) – IP and Mobile IP– Packet delivery and Handover management – Location management – Registration – Tunnelling and Encapsulation - Cellular IP – Internet Protocol Version_4 - Internet Protocol Version_6 – Wireless Application Protocol.		**CO1**
UNIT II	**Long Term Evolution**	**Periods** : **9**
Overview – LTE Evolution - Architecture - Reference Model - Functional Description of LTE network - Reference Points - Control and User Planes LTE advanced, An Overview of 5G requirements, Regulations for 5G,Spectrum Analysis and Sharing for5G.		**CO2**
UNIT III	**Femtocell**	**Periods** : **9**
Femtocell Technology - Femtocell Benefits - User Benefits - Operator Benefits - LTE Femtocell Design Issues - Architecture - Deployment Scenarios - Femtocell Access Control Strategy - CSG Concept - Physical Cell Identity. LTE Femtocell Challenges and Technical Issues- Interference - Spectrum Allocation - Access Mode Impact - Security and Privacy Challenges - Synchronization – Mobility		**CO3**
UNIT IV	**Intelligent Autonomous Communications**	**Periods** : **9**
Introduction – Basic Autonomous Intra-acting systems – Limitations- Intelligent Systems – Self aware systems- Self describing – Self explaining – Self modifying – Self management and Autonomic computing Internet of Things(IoT)		**CO4**
UNIT V	**Future Technologies**	**Periods** : **9**
Challenges – Future technologies – Smart devices – Interaction – Interoperability – Smart physical environment device interaction – Smart Human device Interaction - Human intelligence – Machine Intelligence - Content delivery Networks- Content delivery Evolution- CDN Functions- Distribution Model - Content Generation Tier- Integration Tier – Content delivery and Assembly Tier.		**CO5**

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

Reference Books

1. Savo G. Glisic, "Advanced Wireless Networks -4G Technologies", University of Oulu, Finland .
2. Ashok K Talukder, "Mobile Computing", Tata McGraw Hill, 2010.
3. Stefan Poslad, "Ubiquitous Computing", John Wiley & Sons, 2010.
4. Erik Dahlman, Stefan Parkvall, and Johan Sköld, " 4G LTE/LTE-Advanced for Mobile Broadband", Elsevier 2011.
5. Kaveh Pahlavan and Prashant Krishnamurth, "Principles of Wireless Networks" , Pearson Education, 2004.

CO – PO Mapping

	PO 1	PO	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

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(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
ECZ22	**Programmable Networks**	3	-	-	3	40	60	100
Prerequisite	Data networks and protocols							

Course Outcome	**CO1**	Understanding the fundamental concepts and basic protocols of SDN
	CO2	Understanding Network Virtualization and acquiring the ability to create a simulation environment for SDN
	CO3	Familiarization with the evolution of SDN architecture
	CO4	Understanding the implementation and applications of NFV and SDN
	CO5	Ability to relate the role of advanced concepts of SDN in data centre networks

UNIT I	**Introduction to Programmable Networks**	**Periods** : **9**
History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane-Concepts, Advantages and Disadvantages, the Basics of Open Flow protocol, Active Networking		**CO1**
UNIT II	**Network Virtualization**	**Periods** : **9**
Concepts, Applications, Existing Network Virtualization Framework, Mininet A Stimulation environment for SDN.		**CO2**
UNIT III	**Control Plane**	**Periods** : **9**
Overview, Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hardware-based Programmable Network Hardware.		**CO3**
UNIT IV	**Programming SDNs**	**Periods** : **9**
Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.		**CO4**
UNIT V	**Data Center Networks**	**Periods** : **9**
Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks Traffic Engineering.		**CO5**

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

Reference Books

1. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O’Reilly Media, 2013.
2. Paul Goransson, Chuck Black, Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publishers, 2016.
3. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014.
4. Vivek Tiwari, “SDN and OpenFlow for Beginners”, Amzon Digital Services, Inc., ASIN, 2013.
5. Nick Feamster, Jennifer Rexford and Ellen Zegura, “The Road to SDN: An Intellectual History of Programmable Networks” ACM CCR, 2014.
6. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.
7. Open Flow standards, http://www.openflow.org , 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	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-
CO2	2	-	2	1	1	1	3	1	-	-	-	1	1	1	1
CO3	3	2	2	2	1	2	3	2	-	2	-	1	1	1	1
CO4	3	3	3	2	3	2	2	2	-	2	-	1	1	1	2
CO5	3	2	2	3	2	1	-	1	1	2	-	-	1	1	-

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

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(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
ECZ23	**Ultra Wide Band Communications**	3	-	-	3	40	60	100
Prerequisite	Signal processing, Digital Communication, Antennas and Wireless Communications							

Course Outcome	**CO1**	Understanding the features of UWB and acquiring the knowledge on design and development of antennas for UWB wireless communication
	CO2	Understanding the features and the importance of mmodeling of UWB Wireless Channels in the design of UWB communication system
	CO3	Understanding the effects of interference to and from UWB systems and the ways to mitigate them
	CO4	Knowledge on various modulation schemes of impulse radio UWB
	CO5	Understanding the various aspects of the technologies for UWB transmission, interesting applications of UWB and familiarization of various regulatory bodies and standardization

UNIT I	**UWB for Wireless Communications and UWB Antennas**	**Periods** : **9**
Introduction: UWB Definition-FCC Mask-UWB features UWB Antennas: Antenna Requirements, Radiation Mechanism - Link Budget for UWB System-Short Range Analysis of UWB Antennas		**CO1**
UNIT II	**UWB Wireless Channels**	**Periods** : **9**
Impulse Response Modeling of UWB Wireless Channels: Distribution of Amplitude Fading-Distribution of Time of Arrival-Path Loss-Power-Delay Profiles-RMS Delay Spread.Modified Impulse Response Method-IEEE UWB Channel Model - Frequency Modeling of UWB Channels - Comparison of Time and Frequency Models.		**CO2**
UNIT III	**UWB Interference**	**Periods** : **9**
UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services. Interference of UWB to OFDM System,Narrowband Systems, WiMax - Interference Reduction- Interference Mitigation of Wideband System on UWB using Multicarrier Templates.		**CO3**
UNIT IV	**UWB Signal Processing**	**Periods** : **9**
Data Modulation schemes and their comparison-UWB Multiple Access Modulation-Uniform Pulse Train Spacing-Pseudorandom Time Hopping-Direct Sequence UWB (DS-UWB)- BER of Modulation Schemes- Rake Receiver- Transmit-Reference (T-R) Technique-UWB Range- Data Rate Performance-UWB Channel Capacity.		**CO4**
UNIT V	**UWB Technologies, Applications and Regulations**	**Periods** : **9**
UWB Technologies and their features: Impulse Radio, Pulsed Multiband, Multiband OFDM, Features-Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization. Overview of UWB applications in Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal Computers, Asset Location and Medical applications. Overview of UWB Regulation in various countries, UWB Regulation in ITU, IEEE Standardization.		**CO5**

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

Reference Books

1. Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications", 1st Edition, Springer Science & Business Media B.V, 2010.
2. Reed J H, "An Introduction to Ultra Wideband Communication Systems", Prentice Hall PTR, 2005.
3. Faranak N, "Ultra-Wideband Communications: Fundamentals and Applications", Prentice Hall PTR, 2011.
4. Maria-Gabriella Di Benedetto, Thomas Kaiser, Andreas F. Molisch, Ian Oppermann, Christian Politano and Domenico Porcino, "UWB Communication Systems A Comprehensive Overview", EURASIP Book Series on Signal Processing and Communications, Hindawi Publishing Corporation, Volume 5, 2006.

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	2	1	1	2	2	3	1	-	-	-	-	2	3	2	3
CO2	3	3	2	3	3	3	1	-	-	1	-	2	3	2	3
CO3	3	3	3	3	3	3	1	-	-	1	-	2	3	3	3
CO4	3	3	3	3	3	3	2	-	-	1	-	2	3	3	3
CO5	3	1	2	3	3	2	2	1	-	1	-	2	-	2	-

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

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(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
ECZ24	**Mobile data management**		3	-	-	3	40	60	100
Prerequisite	Wireless Communication and Mobile Communication								
Course Outcome	**CO1**	Understand the concepts of mobile software and mobile computing models							
	CO2	Identify the fundamental concepts of mobile programming and energy management.							
	CO3	Gain knowledge on location and tracking systems.							
	CO4	Know about realization of context awareness and activity recognition.							
	CO5	Understand the concept of mobility and its implications.							

UNIT I	**Fundamentals of Mobile Computing Models**	**Periods**:**9**
Introduction: Challenges in mobile computing, convergence of sensing, computing, and communications, Mobile Software Architectures: Mobile Computing Models, Software architectures - client-servers and proxies to software mobile agents. Middleware and Gateways, Application and services, Internet-Ubiquitous networks, Architecture and three-tier architecture for Mobile Computing.		**CO1**
UNIT II	**Mobile Programing & Energy Management**	**Periods**:**9**
Programming platforms: Overview of different mobile programming environments, Difference with the classical programming practices, Introduction to mobile operating systems, IOS, Android, Windows, Mobile application development. Wireless Energy Management: Measurement of energy consumption, Wi-Fi Power Save Mode (PSM), Constant Awake Mode (CAM), Different Sleep States, Wi-Fi Energy management.		**CO2**
UNIT III	**Localization & Location Privacy of Mobile Data**	**Periods**:**9**
Localization: User location and tracking system, Cell tower localization, Spot localization, Logical location, Ambience fingerprinting, War-driving, Localization without war-driving, Indoor localization, Crowd sourcing for localization. Location Privacy: Different approaches, K-anonymity, Clique Cloak, Location Privacy, Applications with location proof.		**CO3**
UNIT IV	**Context Sensing & Activity Recognition in Mobile devices**	**Periods**:**9**
Context Sensing: Context-Aware system, Automatic Image Tagging, Safety critical applications (case study: determining driver phone use), Energy-efficient Context Sensing, Contextual Ads and Mobile Apps. Activity and Gesture Recognition: Machine Recognition of Human Activities, Mobile Phones to Write in Air, Personalized Gesture Recognition, Content Rating, Recognizing Human without Face Recognition, Phone-to-Phone Action Games, Interface design issues, Touchscreen, Gesture-based Input.		**CO4**
UNIT V	**Mobility Management & Privacy of Mobile data**	**Periods**:**9**
Mobility: Overview of Mobility models, Automatic Transit Tracking, Mapping, Arrival Time Prediction, Augmenting Mobile 3G with Wi-Fi, Vehicular Wi-Fi Hotspots, Code Offload Privacy and Security: Authentication on Mobile Phones, Activity based Password, Finger Taps usage as Fingerprints.		**CO5**

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

Reference Books

1. Evaggelia Pitoura, George Samaras, "Data Management for Mobile Computing", First Edition, Springer Publishers, 1998.
2. PeiZheng, Lionel Ni., "Smart Phone and Next Generation Mobile Computing", First Edition, Elsevier Publishers, 2006.
3. Hansmann, LotharMerk, Martin Niclous, Stober, Principles of Mobile Computing", Second Edition, Dreamtech Press, 2006.
4. Tomasz Imielinski, "Mobile Computing", First Edition, Springer, 1996.
5. Vijay Kumar, "Mobile Database Systems", First Edition, Wiley Publication, 2006.
6. Asoke K. Talukder, Hasan Ahmad, "Mobile Computing Technology- Application and Service Creation", Second Edition, McGraw Hill Education, 2010.
7. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education Asia, 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	2	3	3	3	3	3	3	1	2	2	2	3	1	1
CO2	3	2	3	1	2	1	2	2	1	1	2	2	1	3	3
CO3	2	1	3	1	2	2	2	2	1	2	2	2	1	3	3
CO4	2	1	2	3	1	2	2	2	2	2	2	2	1	3	1
CO5	2	1	2	3	2	3	1	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: **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 Managementfor 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, 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 Morais Cordeiro , 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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-Nonlinearity 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 and A. N. D. Andrea, “Synchronization Techniques for Digital Receivers”, Kluwer, 1997.
3. N. Benuveruto and G. Cherubini, “Algorithms for Communication Systems and their Applications”, Wiley, 2002.
4. H. Meyer and 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.(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
ECZ25	**Space time wireless communications**		3	-	-	3	40	60	100
Prerequisite	Digital Communication								
Course Outcome	**CO1**	Ability to understand the characteristics of fading channel and modelling it							
	CO2	Capable of computing capacity of Space time channels for varying channel assumptions							
	CO3	Ability to analyze the SER performance achieved through spatial diversity							
	CO4	Ability to design Space time codes suitable for ST channels							
	CO5	Ability to understand the ST receivers and examine antennadiversity							

UNIT I	**Space Time Propagation and Channel Characterization**	**Periods** : **9**
Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.		**CO1**
UNIT II	**Capacity of Multiple Antenna Channels**	**Periods** : **9**
Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.		**CO2**
UNIT III	**Spatial Diversity**	**Periods** : **9**
Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.		**CO3**
UNIT IV	**Space Time Coding**	**Periods** : **9**
Delay Diversity Scheme, Alamouti Code, Space-Time block Code, Decoding, Space-Time Trellis Codes: Space-Time Coded Systems, Space-Time Code Word Design Criteria, Design of Space-Time Trellis Codes on Fast Fading Channels, Performance Analysis in a Slow and fast Fading Channel. Delay Diversity as an STTC, Comparison of STBC and STTC.		**CO4**
UNIT V	**MIMO Receivers and Multiuser Detection**	**Periods** : **9**
Receivers for SISO, SIMO, MIMO systems. Iterative MIMO receivers. SISO /MIMO- OFDM modulation, Receivers for MIMO-OFDM. Introduction to MIMO-multiuser, Signaling and receiver design for MIMO MAC and MIMO-BC. Introduction to advanced diversity over MIMO channels for mm wave wireless systems.		**CO5**

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

Reference Books

1. A. Paulraj, RohitNabar, Dhananjay Gore, “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2003.
2. Mohinder Jankiraman, “Space-Time Codes and MIMO Systems”, Artech House, 2004.
3. Sergio Verdu, “Multi User Detection”, Cambridge University Press, 1998.
4. Andre Viterbi, “ Principles of Spread Spectrum Techniques Addison”, Wesley 1995.
5. Kao-Cheng Huang Zhaocheng Wang, “Millimeter Wave Communication Systems”, IEEE Press, NJ and John 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	3	3	2	3	2	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	2	2	3	2	3	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
CO4	3	3	3	3	3	3	3	3	3	2	1	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3

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

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(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
ECZ26	**Internet of Things**		3	-	-	3	40	60	100
Prerequisite	Computer Programming, Networking, Machine learning								
Course Outcome	**CO1**	Understand and learn, the identifier and basics of IoT system							
	CO2	Understand the functionalities of M2M (machine to machine) with necessary protocols							
	CO3	Explore on the use of various hardware, communication technologies							
	CO4	Analyze the functionalities of IoT and the key constraints of IoT Security and Management							
	CO5	Understand the Applications of IOT							

UNIT I	**IOT Overviews**	**Periods** : **9**
Introduction to IOT-Building an Architecture, Sensors, Devices, controllers, connectivity-Data Processing-Identity and Access-Data management-Business processes in IOT-Data privacy and security-Standardization and regulatory limitations		**CO1**
UNIT II	**IoT and M2M**	**Periods** : **9**
Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IoT-Wireless Sensor Network - Characteristics, Applications, Design objectives, challenges.		**CO2**
UNIT III	**IOT Communication Technologies**	**Periods** : **9**
Introduction to wired and wireless communication technologies for IOT- IOT Communication APIs- IOT enabling Technologies- Design of IOT- IOT protocols-IOT communication models-cloud computing-Embedded system-IOT levels and deployment templates-Internet and web layering		**CO3**
UNIT IV	**IOT Reliability, Security, Privacy and Governance**	**Periods** : **9**
Robustness and Reliability-Characteristics and reliability issues-addressing reliability-security and privacy-concepts-security overview-Frame work and privacy in IOT networks-IOT Governance models and issues		**CO4**
UNIT V	**IOT Platform and Applications**	**Periods** : **9**
ThingWorx IOT platform-Architecture overview-connecting various sources –modeling the system-Building Analytical logics-notification and interactions-Air Quality Monitoring-Smart Farming-Smart Parking-Smart Home		**CO5**

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

Reference Books

1. Peter Waher, “Learning Internet of Things”, Packet Publishing Ltd, 2015.
2. Dieter Uckelmann, Mark Harison, Florian Michahelles, “Architecting the Internet of Things”, Springer, 2011.
3. Timothy Chou, “Precision: Principles, Practices and Solutions for the Internet of Things”, Crowdstory Publishing, 2016.
4. Samuel Greengard, “The Internet of Things”, MIT 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		
CO2	3		2			2				3		2		3	
CO3	3	3	2			3				3		2			3
CO4	3	1	3	2		3				2		2	3		
CO5	3					3	2			3		3		3	3

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

Department: **Electronics and Communication Engineering**		Programme: **M.Tech.(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
ECZ27	**Information Security**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	Understanding the Basics of Cryptography, Symmetric Ciphering Techniques and Algorithms
	CO2	Knowledge on Public Key Cryptosystems and authentication schemes with the ability to design and develop security protocols
	CO3	Acquiring knowledge on Network and Internet Security so as to implement and practice for real time applications
	CO4	Ability to understand Wireless threats and its security issues and propose enhanced security solutions
	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-DES Algorithm-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.		**CO1**
UNIT II	**Public Key Cryptography and Authentication Schemes**	**Periods** : **9**
Prime Numbers-Fermat's and Euler's Theorems-Testing for Primality-Chinese Remainder Theorem-Discrete Logarithms-Principles of Public Key Cryptosystems-RSA Algorithm-Key Management-Diffie-Hellman Key Exchange-Elliptic Curve Arithmetic-Elliptic Curve Cryptography-Authentication Requirements-MAC and Hash Functions-Security of MAC and Hash Functions-Message Digest Algorithm (MD5)-Digital Signature Standard- Authentication Protocols		**CO2**
UNIT III	**Network and Internet Security**	**Periods** : **9**
Authentication Application-Kerberos-Web Security Considerations-Secure Sockets Layer and Transport Layer Security-Secure Electronic Transaction-IP Security Overview-IP Security Architecture-Authentication Header Encapsulation Security Payload-Electronic Mail Security-Pretty Good Privacy-S/MIME		**CO3**
UNIT IV	**Wireless Threats and Security**	**Periods** : **9**
Kinds of security breaches-Eavesdropping-Communication Jamming-RF interference-Covert wireless channels-DOS attack-Spoofing-Theft of Services-Traffic Analysis-Cryptographic threats-IEEE 802.11i Wireless LAN Security-Wireless Transport Layer Security-WAP End-to End Security-Security in GSM-UMTS and LTE Authentication and Key Agreement protocol		**CO4**
UNIT V	**System Security, Legal and Ethical Issues**	**Periods** : **9**
Intruders-Intrusion Detection-Password Management-Viruses and Related Threats-Types of Malicious Software-Viruses-Virus Countermeasures-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. Nichols and Lekka, “Wireless Security-Models, Threats and Solutions”, Tata McGraw – Hill, New Delhi, 2002.
3. Merritt Maxim and David Pollino, “Wireless Security”, Osborne/McGraw Hill, New Delhi, 2005.
4. Michael E.Whitman and Herbert J.Mattord, “Principles of Information security”, 3rd edition, 2009.
5. 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.(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
ECZ28	**Advanced MIMO**		3	-	-	3	40	60	100
Prerequisite	Wireless Communication, Advanced Digital Signal Processing								
Course Outcome	**CO1**	Describe and categorize various wireless MIMO channel models.							
	CO2	Understand the aspects of MIMO diversity and spatial multiplexing							
	CO3	Familiarize with the multiple antenna coding and receivers							
	CO4	Explain various ST coding techniques and design optimum receivers for MIMO systems							
	CO5	Prove the existence of some space time codes							

UNIT I	**Information Theoretic aspects of MIMO**	**Periods**:**9**
Information Theoretic aspects of MIMO: Review of SISO fading communication channels, MIMO channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channel models, Capacity of MIMO channels, Ergodic and outage capacity, Capacity bounds and Influence of channel properties on the capacity.		**CO1**
UNIT II	**MIMO Diversity and Spatial Multiplexing**	**Periods**:**9**
MIMO Diversity and Spatial Multiplexing: Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge, Alamouti space time code, MIMO spatial multiplexing, Space time receivers. ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade-off.		**CO2**
UNIT III	**Multiple Antenna Coding and Receivers**	**Periods**:**9**
Multiple antenna coding and receivers: Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers(SISO,SIMO,MIMO),Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal prefiltering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.		**CO3**
UNIT IV	**Space-Time OFDM & MIMO Multi-user Detection**	**Periods**:**9**
STOFDM, spread spectrum and MIMO multiuser detection: SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMO-OFDM, SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO-SS.MIMOMAC,MIMO-BC, Outage performance for MIMO-MU,MIMO-MU with OFDM,CDMA and multiple antennas.		**CO4**
UNIT V	**Space- Time Trellis Codes**	**Periods**:**9**
Space Time Trellis Codes: Representation of STTC, shift register, generator matrix, state-transition diagram, trellis diagram, Code construction, Delay diversity as a special case of STTC and Performance analysis.		**CO5**

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

Reference Books

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", First Edition, Cambridge University Press, 2005.
2. Hamid Jafarkhani, "Space-Time Coding: Theory and Practice", First Edition, Cambridge University Press, 2005.
3. Paulraj, R. Nabar and D. Gore, "Introduction to Space-Time Wireless Communications", First Edition, Cambridge University Press, 2003.
4. E.G. Larsson and P. Stoica, "Space-Time Block Coding for Wireless Communications", First Edition, Cambridge University Press, 2008.
5. Sergio Verdu, "Multi User Detection", First Edition, Cambridge University Press, 1998.
6. Ezio Biglieri, Robert Calderbank et al, "MIMO Wireless Communications", First Edition, Cambridge University Press, 2007.

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	1	3	2	2	3	1		2		3	2	1	2	3	2
CO2	3	2	2	3	2	3		2		3	3	1	3	2	2
CO3	1	2	2	3	2	2		3		2	2	1	3	2	3
CO4	1	3	1	2	3	2		2		2	2	3	3	1	2
CO5	3	3	1	3	3	1		2		2	2	3	3	1	2

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

Department: **Electronics and Communication Engineering**			Programme: **M.Tech.(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
ECZ29	**VLSI for Wireless Communication**		3	-	-	3	40	60	100
Prerequisite	Basic course in communication systems and electronic circuits								
Course Outcome	**CO1**	To compare different receiver architectures							
	CO2	To design LNA circuits							
	CO3	To design and analyse different mixer circuits							
	CO4	To design the building blocks of frequency synthesizer							
	CO5	To explain the issues related to transmitter design							

UNIT I	**Introduction to Receiver Architectures**	**Periods** : **9**
Heterodyne and Other Architectures, Filter Design, Band Selection Filter (BPF1), Image Rejection Filter (BPF2), Channel Filter (BPF3), Nonlinearity and Noise, Derivation of NF, IIP3 of Receiver Front-End		**CO1**
UNIT II	**Low Noise Amplifier**	**Periods** : **9**
Matching Networks, Comparisons of Narrowband and Wideband LNA, Wideband LNA Design: DC Bias, Gain and Frequency Response, Noise Figure, Narrow Band LNA: Impedance Matching, Interpretation of Power Matching, Core Amplifier, Noise Figure, Power Dissipation, Trade-Off Between Noise Figure and Power, Noise Contribution from other Sources, Gain, Other Real-Life Design Considerations		**CO2**
UNIT III	**Mixers**	**Periods** : **9**
Active Mixer : Unbalanced Mixer, Single Balanced Mixer, Double Balanced Mixer: Gilbert Mixer, Qualitative Description of the Gilbert Mixer, Conversion Gain, Distortion, Low Frequency and High Frequency Analysis of Gilbert Mixer, Distortion, Analysis of Noise in Unbalanced Mixer, A complete Active Mixer **Passive Mixer :** Switching Mixer, Unbalanced, Single and Double Balanced Switching Mixer, Distortion in Unbalanced Switching Mixer, Assumptions on Model, Low-Frequency Case, High-Frequency Case, Conversion Gain in Unbalanced Switching Mixer , Noise in Unbalanced Switching Mixer, A practical Unbalanced Switching Mixer, Sampling Mixer Qualitative Description, Non idealities , Conversion Gain and Distortion in Single-Ended Sampling Mixer, Extrinsic Noise in Single Ended Sampling Mixer, High Frequency Limitations		**CO3**
UNIT IV	**Frequency Synthesizer**	**Periods** : **9**
Phase/Frequency Processing Components : PLL-Based Frequency Synthesizer, Phase Detector/Charge Pump, Phase Frequency Detector, EXOR Phase Detector, Charge Pump, Spurs, Kpd, Dividers, Survey of Different Types of Divider, A Complete Divider for DECT Application, VCO, LC Oscillators, Ring Oscillators, Phase Noise, Basic Phase Noise Models **Loop Filter and System Design :** Loop Filter: General Description, Basic Equations and Definitions, First-Order Filter, Second-Order Filter, High-Order Filters, Loop Filter: Design Approaches- Phase Noise Based Approach, Spur-Based Approach, A Complete Synthesizer Design for DECT Application.		**CO4**
UNIT V	**Transmitter Architectures and Power Amplifier**	**Periods** : **9**
Transmitter Back End: General Discussion, Motivations and General Design Philosophy, Direct Conversion and Other Architectures, Quadrature LO Generator, Single Ended RC, Single Ended LC, R-C with Differential Stages, Polyphase I/Q Generator, Divider Based Generator **Power Amplifier Design:** Power Output Control, PA Design Issues, Class A Amplifiers, Class AB/B/C Amplifiers, Choice of Class A vs AB/C Amplifiers, Class E Amplifiers		**CO5**

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

Reference Books

1. Bosco Leung, "VLSI for Wireless Communication", Second Edition, Springer.
2. Emad N Farag, M.I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", Kluwer Publication.
3. Gray, Meyer, Hurst, Lewis, "Analysis and Design of Analog Integrated Circuits", Fifth Edition, Wiley, 2008.
4. T. Lee, "The design of CMOS radio frequency integrated circuits", 2nd edition, Cambridge Press, 2004.
5. B. Razavi, "RF Microelectronics", 2nd edition, Prentice Hall, 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**		**3**		**1**										
CO2	**3**		**3**	**2**	**1**										
CO3	**3**		**3**	**2**	**1**										
CO4	**3**		**3**	**2**	**1**										
CO5	**3**		**3**		**1**										

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.(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
ECZ30	**AI for Wireless Communication**		3	-	-	3	40	60	100
Prerequisite	Basic course in wireless communications								
Course Outcome	**CO1**	To understand the components of cognitive radio							
	CO2	To understand the application of AI for adaptive resource management							
	CO3	To explain the various AI based traffic and mobility prediction methods							
	CO4	To understand the AI based adaptive modulation and coding design process							
	CO5	To understand the principle behind neural network based joint equalization and detection							

UNIT I	**Intelligent Wireless Communications**	**Periods** : **9**
Introduction to Cognitive Radio, the Cognitive Engine – CR design and components. AI based Spectrum Access and Sharing – Learning algorithms for opportunistic spectrum access, Random and Deterministic Approaches, The Adaptive Sequencing Rules Approach, Learning Algorithms for Channel Allocation - Distributed Learning, Game-Theoretic, and Matching Approaches, Deep Reinforcement Learning for DSA, Existing DRL-Based Methods for DSA, Deep Q-Learning for Spectrum Access (DQSA) Algorithm.		**CO1**
UNIT II	**AI based Adaptive Resource Management**	**Periods** : **9**
Coverage and Capacity Optimisation - Machine Learning Techniques for Autonomous Network Management, Data-Driven Base-Station Sleeping Operations by Deep Reinforcement Learning, Dynamic Frequency Reuse through a Multi-Agent Neural Network Approach. Energy Efficiency Optimisation – Self-Organizing Wireless Networks, Traffic Prediction, Cognitive Radio, Future Trends and Challenges.		**CO2**
UNIT III	**AI for Traffic and Mobility Prediction**	**Periods** : **9**
Introduction to Traffic and Mobility Prediction, ANN-Based Models for Traffic and Mobility Prediction, ANN for Traffic Prediction, ANN for Mobility Prediction - Basic LSTM Network for Mobility Prediction, Spatial-Information-Assisted LSTM-Based Framework of Individual Mobility Prediction, Spatial-Information-Assisted LSTM-Based Framework of Group Mobility Prediction.		**CO3**
UNIT IV	**Transmission Intelligence and adaptive Processing**	**Periods** : **9**
Adaptive Modulation and Coding Design – Overview of Machine learning assisted AMC, MCS Schemes Specified by IEEE 802.11n, SL-Assisted AMC, *k*-NN-Assisted AMC, Performance Analysis of *k*-NN-Assisted AMC System, SVM-Assisted AMC, RL-Assisted AMC, Markov Decision Process, Solution for the Markov Decision, Actions, States, and Rewards, Performance Analysis. Nonlinear MIMO Detector **–** A Multihop MIMO Channel Model, Supervised-Learning-based MIMO Detector, Non-Parametric Learning, Parametric Learning, Low-Complexity SL (LCSL) Detector.		**CO4**
UNIT V	**AI for Joint Channel Equalisation and Detection**	**Periods** : **9**
Principles of Equalization and Detection, Overview of Neural Network-Based Channel Equalization, NN-Based Equalization and Detection - Multilayer Perceptron Model, Deep-Learning Neural Network-Based Equalizers, Convolutional Neural Network-Based Equalizers, Recurrent Neural Network-Based Equalizers; Performance of OFDM Systems with Neural Network-Based Equalization - System Model and Network Structure, DNN and CNN Network Structure, Offline Training and Online Deployment.		**CO5**

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

Reference Books

1. Charles Bostian, Thomas Rondeau, “Artificial Intelligence in Wireless Communications”, Artech house publishers, 2009.
2. *Fa-Long Luo* et al., “Machine Learning for Future Wireless Communications”, John Wiley and Sons, 2020.
3. Mazlin Gibert., “Artificial Intelligence for Autonomous Network”, CRC Press, 2018.
4. Erik Dhalman et al., “5G NR: The next generation wireless access network technology”, Academic Press, 2018.
5. Devaki Chandramouli et al., “5G for the Connected World”, Wiley, 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**		**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.(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
ECZ31	**Wireless body area networks**	3	-	-	3	40	60	100
Prerequisite								

Course Outcome	**CO1**	To understand the basic requirements and issues of WBAN.
	CO2	To comprehend knowledge on hardware systems and sensors for WBAN.
	CO3	To apprehend the protocol design strategies for BAN.
	CO4	To apprehend the role of antennas and body centric communication for BAN.
	CO5	To acquire knowledge on the implementation of ultrawide band –WBAN and case studies.

UNIT I	**Introduction to WBAN**	**Periods** : **9**
WPAN – Design requirements, Wireless patient monitoring – system architecture. Wireless technologies for BAN – Stand alone BAN, Zigbee, WLAN, Bluetooth, Regulations , Standards, Interference, Effects of transmission, counter measures. Signal Acquisition and processing Frameworks, wireless interface.		**CO1**
UNIT II	**Hardware Development And System For WBAN**	**Periods** : **9**
Wireless body sensors-Sensor nodes and hardware designs-Wireless systems and platforms-Wireless transceivers and microcontrollers-Existing sensor boards-Design of implanted sensor nodes for WBAN-WBAN Systems-Software programs and monitoring.		**CO2**
UNIT III	**Network and MAC protocol design for BAN**	**Periods** : **9**
Network topologies and configuration-Basics of MAC protocol-Traffic characteristics. Scheduled protocol-Random access protocol-Hybrid MAC protocol-Energy management in WBAN, Patient monitoring network design. Performance analysis of BAN. Cross layer design.		**CO3**
UNIT IV	**Antennas and Body centric wireless communication**	**Periods** : **9**
Miniaturized antennas, Implanted and wearable antennas, Biocompatibility, Antenna parameters, Design of antenna coupling networks, Power and Battery constraints, MICS and ISM bands, Body centric communication - Propagation through Body, channel modeling for wireless BAN, Base station, Link Budget, Parameter estimation and localization techniques.		**CO4**
UNIT V	**Ultra Wideband – WBAN and case studies**	**Periods** : **9**
Introduction to UWB, UWB hardware development – Antennas, transmitter and receiver, Physical Layer for UWB BAN, MAC Scheme, UWB BAN Applications – 8- channel ECG (On Body), Implantable UWB WBAN. Implementation of multi sensor ECG and temperature monitoring system.		**CO5**

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

Reference Books

1. Huan-Bang Li, KamyaYekehYazdandoost Bin-Zhen, “Wireless Body Area Networks”,River Publishers, 2010.
2. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation and applications”, Pan Stanford Publishing Pte. Ltd, Singapore, 2012.
3. Annalisa Bonfiglio, Danilo De Rossi ,”Wearable Monitoring Systems”, Springer, 2011.
4. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems”, Springer, 2013.

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	1	2	1	3	2	2	3	1	2	3	2	2	2	2	1
CO2	2	1	1	2	2	2	3	2	2	2	1	2	2	1	3
CO3	1	2	2	3	2	3	3	2	1	1	1	2	2	2	3
CO4	1	2	2	3	2	3	3	1	2	2	1	3	2	1	3
CO5	3	2	3	3	3	3	3	2	3	3	3	3	1	2	3

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