CURRICULUM AND DETAILED SYLLABI

FOR

M.TECH DEGREE PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

TELECOMMUNICATION ENGINEERING

SEMESTERS I TO IV

2020 SCHEME
(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

MAR IVANIOS VIDYANAGAR, NALANCHIRA, THIRUVANANTHAPURAM – 695015, KERALA.

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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electronics and Communication Engineering Education and Research for the service of humanity.

Mission:

To provide quality Engineering Education and to carry out Research in the field of Electronics and Communication Engineering addressing the challenges faced by the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PROGRAMME OUTCOMES (POs)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.Tech Telecommunication Engineering

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of M. Tech Programme is placed in one of the seven categories as listed in Table 1 below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Number of Courses	Total Credits
1	Programme Core Courses	PCC	7	24
2	Laboratory Courses		2	2
3	Programme Elective Courses	PEC	5	15
4	Mandatory Credit Course (Research Methodology)	MCC	1	2
5	Seminar	PWS	2	4
6	Mini Project		1	2
7	Project		2	18
			Total Mandatory Credits	**67**

*Note: 67 credits have been the requirement for award of degree in all M.Tech Programmes of the College which was approved by the University.

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**Total Credits**
Credits for Courses	22	19	14	12	**67**

SEMESTER I							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PCC	MA0P60C	Applied Linear Algebra	3	0	0	3
B	PCC	EC1P60A	Random Processes and Applications	3	1	0	4
C	PCC	EC1P60B	Advanced Digital Communication	3	1	0	4
D	PCC	EC1P60C	Advanced Digital Signal Processing	3	0	0	3
E	PEC	EC1P61X	Elective I	3	0	0	3
S	MCC	MC0P60A	Research Methodology	0	2	0	2
T	PCC	EC1P68A	Telecommunication Lab I	0	0	2	1
U	PWS	EC1P69A	Seminar I	0	0	2	2
			Total	**15**	**4**	**4**	**22**

ELECTIVE I

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
E	PEC	EC1P61A	Optical Communication Systems	3	0	0	3
		EC1P61B	Modeling and Simulation of Communication Systems	3	0	0	3
		EC1P61C	Spread Spectrum and CDMA Systems	3	0	0	3

SEMESTER II							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PCC	EC1P60D	Estimation and Detection Theory	3	1	0	4
B	PCC	EC1P60E	Antenna Theory and Design	3	0	0	3
C	PCC	EC1P60F	Wireless Communication and Networks	3	0	0	3
D	PEC	EC1P62X	Elective II	3	0	0	3
E	PEC	EC1P63X	Elective III	3	0	0	3
T	PCC	EC1P68B	Telecommunication Lab II	0	0	2	1
W	PWS	EC1P69B	Mini Project	0	0	4	2
			Total	**15**	**1**	**6**	**19**

ELECTIVE II

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
D	PEC	EC1P62A	Adaptive Signal Processing	3	0	0	3
		EC1P62B	Digital Microwave Communication	3	0	0	3
		EC1P62C	Embedded Systems for Communication	3	0	0	3
		EC1P62D	Advanced Coding Theory	3	0	0	3

ELECTIVE III

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
E	PEC	EC1P63A	Information Theory	3	0	0	3
		EC1P63B	Image and Video Processing	3	0	0	3
		EC1P63C	High Performance Communication Networks	3	0	0	3
		EC1P63D	Digital System Design	3	0	0	3

SEMESTER III							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PEC	EC1P71X	Elective IV	3	0	0	3
B	PEC	EC1P72X	Elective V	3	0	0	3
U	PWS	EC1P79A	Seminar II	0	0	2	2
W	PWS	EC1P79B	Project (Phase I)	0	0	12	6
			Total	**6**	**0**	**14**	**14**

ELECTIVE IV

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
A	PEC	EC1P71A	Neuro Fuzzy systems	3	0	0	3
		EC1P71B	Secure Communication	3	0	0	3
		EC1P71C	Space Time Coding and MIMO Systems	3	0	0	3
		EC1P71D	Advanced VLSI DSP Architectures	3	0	0	3

ELECTIVE V

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
B	PEC	EC1P72A	WDM Optical Network and Optical switching	3	0	0	3
		EC1P72B	RF MEMS	3	0	0	3
		EC1P72C	Radio Frequency System Design	3	0	0	3
		EC1P72D	Machine Learning for Communication	3	0	0	3

SEMESTER IV							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
W	PWS	EC1P79C	Project (Phase II)	0	0	24	12
			Total	**0**	**24**	**12**	**12**

SEMESTER – I

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0P60C	Applied Linear Algebra	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES: This course introduces students to the basic ideas of abstract algebra like group, ring and field and covering important ideas of linear algebra. A brief course in vector spaces, linear transformation, orthogonality eigen values and eigen vectors are useful to find solutions in many problems in the field of signal processing.

ii)COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Formulate problems in abstract algebra framework.	Apply
CO 2	Apply the concept of vector spaces in appropriate problems.	Apply
CO 3	Develop the skills to identify linear transformation and its role in linear systems.	Apply
CO 4	Apply the concept of orthogonality and inner product spaces.	Apply
CO 5	Apply matrix factorizations to solve various problems.	Apply

iii) SYLLABUS

Vector spaces, Linear independence, Linear Transformation, Coordinate transformation, System of linear equations, projection, pseudo inverse, Generalized Eigen vectors, Singular Value Decomposition

iv) REFERENCES

1. Hoffman Kenneth and Kunze Ray, *Linear Algebra*, Prentice Hall ofIndia.
2. David.C Lay, *Linear Algebra and its Applications*, third edition, Dorling Kinderselypvt ltd.
3. G.F.Simmons, *Topology and Modern Analysis*,McGraw-Hill.
4. Frazier, Michael W. *An Introduction to Wavelets Through Linear Algebra*, Springer Publications.

v) COURSE PLAN

Module	Contents	No. of hours
I	Algebraic Structures: Group, Ring, Field Vector Spaces, Subspaces, Linear Combinations, Subspace spanned by set of vectors, Linear dependence and Linear independence, Spanning set and basis, Finite dimensional vectorspaces	**7**
II	Solutions to Linear System of Equations: Simple systems,Homogeneous and Non-homogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity Consistency conditions in terms of rank, General Solution of a linear system, Elementary Row and Column operations, Row Reduced Form, existence and uniqueness of solutions, projection, least square solution -pseudo inverse.	**8**
III	Linear Transformations -four fundamental subspaces of linear transformation -inverse transformation - rank nullity theorem - Matrix representation of linear transformation,Change of Basis operation	**7**
IV	Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Expansion in terms oforthonormal basis, Orthogonal complement, Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagoras Theorem	**8**
V	Eigenvalue – Eigenvector pairs, characteristic equation Algebraic multiplicity, Eigenvectors, Eigenspaces and geometric multiplicity, Diagonalization criterion The diagonalizing matrix, Projections, Decomposition of the matrix in terms of projections, Real Symmetric and Hermitian matrices, Properties of Eigen values, Eigen vectors, Unitary/Orthogonal diagonalizability of Complex Hermitian/Real Symmetric Matrices, Spectral Theorem, Positive and Negative Definite and Semi Definite matrices.	**8**
VI	General Matrices: Rank, Nullity, Range and Null Space of AA^T and A^TA, Singular Values, Singular Value Decomposition, Pseudoinverse and Optimal solution of a linear system of equations, The Geometry of Pseudoinverse.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60A	Random Processes and Applications	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES: The objective of this course is

- To familiarize the student with the theory and applications of probability theory.
- To aid in understanding phenomena which evolve with respect to time in a probabilistic manner.
- To introduce the student to concepts in statistical signal analysis.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Apply the fundamental knowledge of basic probability concepts.	Apply
CO 2	Apply probability distributions for various applications.	Apply
CO 3	Analyze various random processes.	Analyze
CO 4	Explain the various applications of probability theory.	Understand

iii) SYLLABUS

Probability theory, Random variable, Probability Density function, Conditional and Joint Distributions and densities, Functions of Random Variables, Expectation, Conditional Expectations.

Random Vector, Random Sequences, Random Processes, Chapman- Kolmogorov Equations,WSS Processes and LTI Systems, Inequalities, Central limit theorem, Random Sequences, Advanced Topics.

iv) REFERENCES:

1. Henry Stark and John W. Woods, *Probability and Random Processes with Applications to Signal Processing*, Pearson Education, 3/e, 2002.
2. Athanasios Papoulis and S. UnnikrishnaPillai, *Probability, Random Variables and Stochastic Processes*, TMH, 4/e, 2002.
3. Oliver C. Ibe., *Fundamentals of Applied Probability and Random Process, Elsevier, 2005.*
4. Gray, R. M. and Davisson L. D., *An Introduction to Statistical Signal Processing*, Cambridge University Press, 2004. (Available at: http://www.ee.stanford.edu/~gray/sp.pdf)
5. Gardner, W. A., *Introduction to Random Processes with applications to Signals and Systems*, 2nd edition, McGraw-Hill, Inc., 1990.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Sets, Fields and Events, Definition of probability, Joint, Conditional and Total Probability, Bayes' Theorem and applications. **Random Variable**:- Definition, Probability Distribution Function, Probability Density function, Common density functions, Continuous, Discrete and Mixed random Variables.	8
II	**Conditional and Joint Distributions** and densities, independence of random variables. **Functions of Random Variables**: One function of one random variable, One function of two random variables, Two functions of two random variables.	10
III	**Expectation**: Fundamental Theorem of expectation **Moments**, Joint moments, Moment Generating functions, Characteristic functions, Conditional Expectations Correlation and Covariance, Jointly Gaussian Random Variables. **Random Vector**: Definition, Joint statistics, Covariance matrix and its properties.	11
IV	**Random Processes**:-Basic Definitions, Poisson Process, Wiener Process, Markov Process, Birth- Death Markov Chains, Chapman- Kolmogorov Equations, Stationarity, Wide sense Markov Process Stationarity, WSS Processes and LTI Systems, Power spectral density, White Noise.	12
V	**Chebyshev and Schwarz Inequalities**, Chernoff Bound, Central Limit Theorem. **Random Sequences**: Basic Concepts, WSS sequences and linear systems, Markov Random sequences, Markov Chains, **ConvergenceofRandomSequences**:Definitions,Lawsoflarge numbers.	11
VI	**Advanced Topics**:Ergodicity, Karhunen-LeoveExpansion, Representation of Band limited and periodic Processes: WSSperiodic Processes, Fourier Series for WSS Processes	8
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60 B	Advanced Digital Communication	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES: The course introduce the different aspects of digital communication over various channels and give an idea on the advances in Multichannel and Multicarrier Systems design.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the characterization and modulation of communication signals.	Understand
CO2	Design the optimum receiver for Additive Gaussian Noise Channels, over Band limited Channels.	Apply
CO 3	Analyse various equalization techniques.	Analyse
CO 4	Apply the concept of spread spectrum and multicarrier systems.	Apply
CO 5	Explain the communication through fading multipath channel.	Understand

iii) SYLLABUS

Digital Communication over Additive Gaussian Noise Channels- Optimum waveform receiver in additive white Gaussian noise. Digital Communication over Band limited Channels- Optimum receiver for channels with ISI and AWGN- Equalization Techniques. Spread spectrum Communication- modelling, application and synchronization of spread spectrum signals. Digital Communication over Fading Multipath Channels. Multiuser Communication - techniques and capacity.

iv)REFERENCES

1. John G. Proakis, *Digital Communications*, 4/e, McGraw-Hill, April 2014.
2. Andrea Goldsmith*," Wireless Communications",* Cambridge University Press 2005.
3. Edward. A. Lee and David. G. Messerschmitt*, "Digital Communication*", Allied Publishers (3rd edition), 2003.
4. Viterbi, A. J., and J. K. Omura. *Principles of Digital Communication and Coding.* NY: McGraw-Hill, 1979. ISBN: 0070675163.
5. Marvin K Simon, Sami M Hinedi, William C Lindsey, *Digital Communication Techniques – Signal Design & Detection*, PHI, 2015.
6. Bernard Sklar*," Digital Communications:* Fundamentals and applications ", Prentice Hall 2001.

v) COURSE PLAN

Module	Contents	No. of hours
I	Characterization of Communication Signals and Systems: Representation of band pass signals and systems. Signal space representation. Representation of digitally modulated signals: memory less modulation methods, linear modulation with memory. Power spectra, Bandwidth efficiency.	**10**
II	Optimum receiver for additive white Gaussian noise channel: correlation demodulator, matched filter demodulator, optimum detector. Performance of optimum receiver for memory less modulation techniques: probability of error for binary modulation and M-arry orthogonal signals, QPSK, QAM.	**10**
III	Communication through band limited channels: Signal design for band limited channels. Optimum receiver for channels with ISI and AWGN. Equalization techniques: Linear equalization, Decision feedback equalization, ML detectors. Adaptive equalization: Algorithms	**10**
IV	Multicarrier Systems: Data transmission with multiple carriers, Multicarrier modulation with overlapping sub channels, Mitigation of subcarrier fading. Discrete implementation of multicarrier modulation. Challenges in multicarrier systems.	**10**
V	Digital communication through fading multipath channel: characterization of fading multipath channel. The effect of signal characteristics on the choice of a channel model. Frequency-non selective slowly fading channel. Digital signaling over a frequency- selective slowly fading channel.	**10**
VI	Multiple access techniques- Capacity of multiple access methods. Spread spectrum principles, processing gain and jamming margin. Direct sequence spread spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS). Synchronization of spread spectrum systems. CDMA signal and channel models, optimum receiver. Random access methods	**10**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60C	Advanced Digital Signal Processing	PCC	3	0	0	3	2020

i) **COURSE OBJECTIVES:** The course aims to provide an overview of time frequency analysis and hence the significance of wavelet transform and its applications, to familiarize with multirate sampling principles, various linear prediction analysis and to equip the students with power spectrum estimation of signals using parametric and non-parametric methods.

ii) **COURSE OUTCOMES:**

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Analyse multirate systems.	Analyse
CO 2	Apply time frequency analysis and hence the significance of wavelet transform.	Apply
CO 3	Analyse the various wavelets transforms for applications like data compression.	Analyse
CO 4	Illustrate the concept of Power spectrum estimation of signals and Power spectral density.	Apply
CO 5	Explain the linear prediction and optimization algorithms.	Understand

iii) SYLLABUS

Multirate signal processing, Filter banks, Continuous and Discrete wavelet transforms, Filterbank interpretation., Linear Prediction. Adaptive filters

iv) REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, *Digital signal Processing*, Pearson Education India, 4th edition, 2007.
2. K. P. Soman, *Insight into wavelets, From theory to practice*, Prentice Hall India, 3rd edition, 2010.
3. P.P. Vaidyanathan, *Multi-rate systems and filter banks*, Pearson Education India, 2006.
4. Bopadikar and Rao, *Wavelet Transforms: Introduction to Theory and Applications*, Pearson Education Asia, 1999.
5. L. Cohen, *Time Frequency Analysis*, Prentice Hall, 1995.
6. Simon Haykin, *Adaptive Filter Theory*, NJ:Pearson, 5th edition Upper Saddle River, , 2014.
7. G Strang& T Nguyen, *Wavelets and Filterbanks*, Wellesley-Cambridge Press. 1996.
8. M Vetterli& J Kovacevic, *Wavelets and subband coding*, Prentice Hall, 2nd.

v) COURSE PLAN

Module	Contents	No. of hours
I	Basics of Multirate systems and its application, up sampling and Down - Sampling, Fractional Sampling rate converter. Frequency domain analysis-anti aliasing and anti-imaging filter.	**8**
II	Polyphase decomposition. Efficient realization of Multirate systems. Uniform filter banks and its implementation using polyphase decomposition. Two channel Quadrature Mirror Filter Banks, Perfect Reconstruction.	**8**
III	Time Frequency Analysis, Heisenberg's uncertainty principle. Short time Fourier transform. Continuous Wavelet Transform and its properties.	**6**
IV	Multi Resolution Analysis. Discrete Wavelet Transform, Orthonormal Wavelet Analysis – Filter bank interpretation. Application of wavelet transform for data compression, image and speech.	**8**
V	Power spectrum estimation of signals Power spectral density. Non parametric methods: periodogram, Backman-Tuckey method. Parametric method: ARMA, AR processes Yule-Walker method.	**8**
VI	Linear Prediction -Forward and Backward Prediction - Levinson-Durbin Algorithm --basic of steepest descend algorithm-adaptive filters-LMS algorithm- applications.	**7**
	Total hours	**45**

Course Code	Course Name	Categor y	L	T	P	Credit	Year of Introduction
EC1P61A	Optical Communication Systems	PEC	3	0	0	3	2020

i)COURSE OBJECTIVES:

The objective of this course is to provide a comprehensive understanding of optical communication systems. This course provides coverage of basic optical technology including physical aspects of light propagation, fiber optic components and its characteristics and modulation/demodulation techniques ,dispersion management techniques, link design and system design, soliton and WDM based transmission system .

ii)COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic principle, transmission characteristics of optical fiber.	Understand
CO 2	Explain various optical sources, amplifiers, detectors, dispersion management techniques and transmission system parameters.	Understand
CO 3	Apply the concepts of optical source, fiber and detector in modelling a system.	Apply
CO 4	Describe the concept of soliton technologies in an optical system.	Understand
CO 5	Explain various multiplexing techniques in an optical system.	Understand

iii)SYLLABUS

Optical Fibers – Dispersion, Fiber losses, Nonlinear optical effects. Optical Transmitters- LED, Semiconductor lasers, Hetrostructures- VCSEL, Transmitter design. Modulation. Optical receivers Detectors, Receiver design, Noise, Sensitivity- BER, Sensitivity degradation. Architecture and Design of Light wave systems- Loss limited and Dispersion limited light wave systems. Link budget analysis. Optical amplifiers- Various types, Design of EDFAs. Various Techniques for Dispersion management. Soliton based systems- Impact of amplifier noise-Timing Jitter, Gordon – Hauss Effect, Bit Error Rate Performance. WDM systems – Components and performance issues. Coherent light wave systems.

iv) REFERENCES:

1. Gerd Keiser, *Optical Fiber Communications*, 5/e McGraw Hill, 2013
2. John M Senior, *Optical communications*, 3/e, Pearson, 2009.
3. Govind P. Agrawal, *Nonlinear Optics*,Academic Press, 2013.
4. Hasegawa, *Solitons in Optical Communications*, Clarendon Press, 1995.

v) COURSE PLAN

Module	Contents	No. of hours
I	Optical Fibers: basic concepts, mode theory, Fiber impairments. Optical sources-LED and LASER: basic theory, structure, working and characteristics. Design of transmitter.	**7**
II	Optical receivers -Basic concepts, Detectors, Receiver design, Noise, Sensitivity- BER, Sensitivity degradation	**8**
III	Architecture and Design of Light wave systems- Loss limited and Dispersion limited light wave systems. Link budget analysis.	**8**
IV	Optical amplifiers- Various types, Design of EDFAs. Various Techniques for Dispersion management	**7**
V	Soliton based systems- Impact of amplifier noise-Timing Jitter, Gordon – Hauss Effect, Bit Error Rate Performance.	**7**
VI	WDM systems – Components and performance issues. Coherent light wave systems-Concepts, Modulation Formats and Bit Error Rate Performance.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P61B	Modeling and Simulation of Communication Systems	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: Goal of this course isto provide an insight into the basic concepts of modeling and simulation of Communication Systems. Also to study and evaluate the behavior and performance of the systems.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic concepts and properties of random variables, random processes and models.	Understand
CO 2	Explain fading and multipath channels that are used in 3G/4G communication systems.	Understand
CO 3	Estimate the parameters such as average level, power spectral density, delay and phase of the waveform.	Analyze
CO 4	Estimate the bit error rate using Monte Carlo simulation.	Analyze
CO 5	Evaluate the performance of the communication system model using verification and validation techniques.	Evaluate

iii) SYLLABUS

Modelling and simulation of systems, error sources in simulation, modelling of communication channels, validation, performance estimation and evaluation, analysis of simulation results.

iv) REFERENCES:

1. M.C. Jeruchim, Philip Balaban,K.SamShanmugam, *Simulation of communication systems,* Kluwer Academic/Plenum Press, New York, 2000
2. Raj Jain. *The Art of Computer Systems Performance Analysis*, John Wiley and Sons, 1991 (Chapter 25).
3. Dennis Silage, *"Digital Communication Systems using MATLAB and SIMULINK",* Book Stand Publications, 2009.
4. John G Proakis, Salehi, Massoud, *"Digital Communications",* Academic Internet Publishers, Fifth Edition, 2009.

v) COURSE PLAN

Module	Contents	No. of hours
I	Modelling and Simulation Approach: Basic concepts of modelling – modelling of systems, devices, random process and hypothetical systems. Error sources in simulation. Validation of devices, system models and random process models, simulation environment and software issues. Role	**8**

	of simulation in communication system and random process. Steps involved in simulation study.	
II	Generation and Parameter Estimation: Monte Carlo simulation, random number Generation, Generating independent random sequences. Parameter estimation: Estimating mean, variance, confidence interval, Estimating the Average Level of a Waveform, Estimating the Average power of a waveform, Power Spectral Density of a process, Delay andPhase.	**8**
III	Modelling of Communication Systems: Information sources, source coding, base band modulation, channel coding, RF modulation, filtering, multiplexing, detection/demodulation-carrier and timing recovery for BPSK and QPSK.	**7**
IV	Communication Channel Models: Fading and multipath channels- statistical characterization of multipath channels and time-varying channels with Doppler effects, models for multipath fading channels. Methodology for simulating communication systems operating over fading channels.	**8**
V	Performance Estimation and Evaluation: Estimation of Performance Measures - Estimation of SNR, Performance Measures for Digital Systems, Importance sampling method.	**7**
VI	Analysis of simulation Results: Model Verification Techniques, Model Validation Techniques, Transient Removal, Terminating Simulations, Stopping Criteria, Variance Reduction. Case Studies: (1) Performance of 16-QAM equalized Line of Sight Digital Radio Link, (2) performance evaluation of CDMA Cellular Radio System.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P61C	Spread Spectrum and CDMA Systems	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The goal of this course is to give an overview of wireless architecture, modulation and demodulation techniques, spread spectrum communication, calculation capacity of CDMA systems, coding and decoding process in CDMA, effects of interference in CDMA systems and synchronization in CDMA wireless communication systems.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Describe the fundamentals of Spread Spectrum Techniques.	Understand
CO 2	Interpret the performance of Spread Spectrum system under various channel conditions.	Apply
CO 3	Discuss the different Spread Spectrum multiple access networks.	Understand
CO 4	Explain the fundamentals of CDMA systems.	Understand

iii) SYLLABUS

Introduction to spread spectrum communication. Properties and generation of spreading sequences. Synchronization and Tracking of spread spectrum systems. Performance analysis of spread spectrum system under AWGN channel. Performance of Spread Spectrum Multiple Access Networks. Introduction to spread spectrum multiple access in cellular environments.Multi-user Detection.CDMA Systems.

iv) REFERENCES:

1. R. L. Peterson, R. Ziemer and D. Borth: *Introduction to Spread Spectrum Communications*, Prentice Hall, 1995.
2. Vijay K. Garg, Kenneth F. Smolik, Joseph E. Wilkes: *Applications of CDMA in Wireless/Personal Communications,* Prentice Hall, 1997.
3. M. K. Simon, J. K. Omura, R. A. Scholtz and B. K. Levitt: *Spread Spectrum Communications Handbook,* McGraw Hill, New York, 2002.
4. Cooper and McGillem: *Modern Communications and Spread Spectrum.* McGraw-Hill, 1986.
5. J. G. Proakis: *Digital Communications,* McGraw Hill, 4th edition, 2001.

v) COURSE PLAN

Module	Contents	No. of hours
I	Fundamentals of Spread Spectrum : Introduction to spread spectrum communication, pulse noise jamming, low probability of detection, direct sequence spread spectrum, frequency-hopping and time hopping spread spectrum systems, correlation functions	**7**
II	Spreading sequences- maximal-length sequences, gold codes, Walsh orthogonal codes- properties and generation of sequences. Synchronization and Tracking: delay lock and tau-dither loops, coarse synchronization principles of serial search and match filter techniques.	**8**
III	Performance Analysis of SS system: Performance of spread spectrum system under AWGN, multiuser Interference, jamming and narrow band interferences Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, RAKE receiver Capacity. Coverage and Control of Spread Spectrum Multiple Access Networks. Error probability of DS-CDMA system under AWGN and fading channels.	**8**
IV	Basics of spread spectrum multiple access in cellular environments, reverse Link power control, multiple cell pilot tracking, soft and hard handoffs, cell coverage issues with hard and soft handoff, spread spectrum multiple access outage, outage with imperfect power control, Erlang capacity of forward and reverse links.	**7**
V	Multi-user Detection -MF detector, decorrelating detector, MMSE detector. Interference Cancellation: successive, Parallel Interference Cancellation, performance analysis of multiuser detectors and interference cancellers.	**7**
VI	CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards, Principles of Multicarrier communication, MCCDMA and MC-DS-CDMA.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MC0P60A	RESEARCH METHODOLOGY	MCC	0	2	0	2	2020

i) COURSE OBJECTIVES:

Goal of this course is to prepare the student to do the M. Tech project work with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify the appropriate research methodology. The student will be able to write a technical paper based on the project findings.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain research ethics	Understand
CO 2	Explain Citation, Impact factor and Plagiarism.	Understand
CO 3	Explain the need for IPR in fostering research work, leading to creation of improved products, thus helping in economic growth and social benefits.	Understand
CO 4	Explain research problem formulation.	Apply
CO 5	Analyze research related information	Apply
CO 6	Write a technical paper	Understand

iii) SYLLABUS

Introduction to Research Methodology- Meaning of research, types of research, research problem- scope-objectives, data collection and analysis, literature review.

Ethical issues- Research ethics, Plagiarism, Effective technical writing.

Developing a Research Proposal, Format of research proposal-presentation-assessment by a review committee.

Copy right-royalty-Intellectual property rights and patent law, Patents, Designs, Process of Patenting and Development, Procedure for grant of patents.

Scope of Patent rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. Administration of Patent system- Biological systems- Computer software.

iv) REFERENCES

1 Stuart Melville and Wayne Goddard, *Research methodology: an introduction for science and engineering students*, Lansdowne [South Africa] : Juta, 1996.

2 Wayne Goddard and Stuart Melville, *Research Methodology: An Introduction*, 2^{nd} edition, Lansdowne [South Africa] : Juta, 2001.

3 Ranjit Kumar, *Research Methodology: A Step by Step Guide for beginners*, 3rd Edition, SAGE Publications Ltd; 2011.

4 Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd; 2007.

5 Mayall, *Industrial Design*, McGraw Hill, 1992.

6 Niebel, "*Product Design*", McGraw Hill, 1974.

7 Asimov, *Introduction to Design*, Prentice Hall, 1962.

8 Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in the New Technological Age*, Clause 8 Publishing, 2016.

9 Ramappa T., *Intellectual Property Rights Under WTO*, S. Chand, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Research Methodology: Motivation towards research, Types of research. Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law – Copyleft Openaccess-Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	**6**
II	Defining and formulating the research problem -Literature Survey-Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	**5**
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous work	**4**

IV	Data Collection and analysis: Analyze the chosen papers and study the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data.	**5**
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-use of tools like Latex.	**5**
VI	Identification of a simple research problem– Literature survey-Research design- Methodology –paper writing based on a hypothetical result.	**5**
	Total hours	**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P68A	Telecommunication Lab-1	PCC	0	0	2	1	2020

i) COURSE OBJECTIVES:

The goal of this course is to expose the students to simulation of various communication systems, generation of random process and construction of networks using NS2

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Apply probability distributions for different applications random process using MATLAB.	Apply
CO 2	Design Band limited channels using MATLAB.	Apply
CO 3	Demonstrate various modulation and synchronization techniques using MATLAB.	Apply
CO 4	Construct a network using NS2 and study different statistics	Apply

iii) LIST OF EXERCISES / EXPERIMENTS

Random Processes– Generation of discrete time i.i.d. random processes with different distributions (Bernoulli, Binomial, Geometric, Poisson, Uniform, Gaussian, Exponential, Laplacian, Rayleigh, Rician) - pmf/pdf estimation, AR, MA and ARMA processes - spectral estimation -Visualization of Central Limit Theorem, Whitening Filter.

Communication system Design for Band limited Channels - Signal Design for Zero ISI and Controlled ISI - Partial Response Signaling.

Carrier Phase Modulation and Quadrature Amplitude Modulation- BER Performance in AWGN channel.

Synchronization in Communication Systems: Carrier and Clock Synchronization-Frequency Offset Estimation and Correction.

Modeling and Simulation of Networks using NS2/OPNET: Unicast Routing Basics -

Measurements and Statistics of Delays, Throughput, and Packet Behavior - TCP and Packet Trace Tools - Real-Audio vs. TCP-based Traffic.

TCP Connections- Congestion and Congestion Control Parameters. MAC Protocols: CSMA and CSMA/CD in Ethernet and LAN Environments. Multimedia Networking applications: RTSP andTransport of Video using UDP. OMNEST and OMNET

iv) REFERENCES:

1. Henry Stark and John W. Woods, *"Probability and Random Processes with Applicationsto Signal Processing"*,3/e, Pearson Education, 2001.
2. TeerawatIssariyakul, EkramHossain**,** *Introduction to Network Simulator NS2*, Springer, 2012.
3. John G. Proakis, *Digital Communications*, 5/e, McGraw-Hill, 2016.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P69A	Seminar I	PWS	0	0	2	2	2020

i) COURSE OBJECTIVES:
To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

ii) APPROACH:
Students shall make a presentation for 20-25 minutes based on the detailed study on the topic and submit a report of the study.

iii) COURSE OUTCOMES
Upon successful completion of the Seminar, the student should be able to:

Course Outcomes	Description	Level
CO 1	Identify promising new directions of various cutting edge technologies related to the branch of study.	Remember
CO 2	Organize information and gain technical knowledge after the study of research papers in the related area.	Analyse
CO 3	Develop effective written and oral communication	Create

SEMESTER – II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60D	Estimation and Detection Theory	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES:

The objective of this course is to

1. Familiarize the basic concepts of detection theory, decision theory and elementary hypothesis testing.
2. Acquire knowledge about parameter estimation, and linear signal waveform estimation.
3. Get a broad overview of applications of detection and estimation.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Analyse signal detection in the presence of noise.	Analyse
CO 2	Analyse various estimation methods.	Analyse
CO 3	Apply the concepts of estimation and detection in various signal processing applications.	Apply
CO 4	Explain Linear Signal Waveform Estimation methods.	Understand

iii) SYLLABUS

Detection theory, Hypothesis testing, Detection with unknown signal parameters, Non parametric detection, Parameter estimation, Cramer-Rao lower bound, Linear Signal Waveform Estimation, Levinson Durbin and innovation algorithms. Applications of detection and estimation.

iv) REFERENCES:

1. S.M. Kay, *Fundamentals of Statistical Signal Processing: Detection Theory*, Prentice Hall, 1998
2. S.M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, Prentice Hall, 1993
3. H.L. Van Trees, *Detection, Estimation and Modulation Theory, Part I*, Wiley, 1968
4. H.V. Poor, *An Introduction to Signal Detection and Estimation*, 2nd edition, Springer, 1994.
5. L.L. Scharf, *Statistical Signal Processing, Detection and Estimation Theory*, Addison-Wesley:1990

v) COURSE PLAN

Module	Contents	No. of hours
I	Detection Theory, Decision Theory, and Hypothesis Testing: Elementary hypothesis testing, Neyman Pearson Theorem, Minimum probability of error, Bayes risk, Multiple hypothesis testing.	**10**
II	Matched filter, Composite hypothesis testing: Generalized likelihood-ratio test. Detection of Signals with unknown Amplitude, Chernoff bound.	**10**
III	Parameter Estimation: Minimum Variance Unbiased Estimator, Cramer-Rao lower bound, Fisher information matrix, Linear Models, Best Linear Unbiased Estimator.	**10**
IV	Maximum Likelihood Estimation, Invariance principle, Least Square Estimation, Non-linear least square estimation, Minimum mean square estimation, Minimum mean absolute error, Maximum A Posteriori Estimators.	**10**
V	Linear Signal Waveform Estimation: Wiener Filter, Kalman Filter, Choosing an estimator.	**10**
VI	Applications of detection and estimation**:** Applications in diverse fields such as communications, system identification, adaptive filtering, pattern recognition, speech processing, and image processing.	**10**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60E	Antenna Theory and Design	PCC	3	0	0	3	2020

i) COURSE OBJECTIVE: Goal of this course is to give idea about analysis and design of antennas and antenna arrays.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic principles and properties of various types of antennas.	Understand
CO 2	Analyse helical antennas and other various antenna types.	Analyse
CO 3	Explain the different types of dipole antennas.	Understand
CO 4	Design of horn, patch and other various antennas.	Apply
CO 5	Design antenna arrays considering various practical aspects.	Apply

iii) SYLLABUS

Review of Antenna Parameters, Antenna matching. Review of dipole antennas, Monopole antennas, Vee and rhombic antennas. Folded dipole. Analysis of Circular Loop and Biconical Antenna. Helical Antennas. Current induced in a dipole antenna. Near fields of linear antennas, arrays of parallel dipoles, Yagi-Uda antennas. Aperture antenna. Radiation from open-ended wave-guides, horn antennas, optimum horn design, rectangular micro-strip antennas – Field analysis and design, parabolic reflector antennas, aperture-field and current-distribution methods, radiation patterns of reflector antennas, dual-reflector antennas, lens antennas. Frequency independent antennas. Antenna arrays. Grating lobes. One dimensional arrays. Concept of beam steering. Design of array. Adaptive Beam forming, 2D arrays.

iv) REFERENCES

1. Constantine A Balanis, Antenna *Theory - Analysis and Design*, 3/e John Wiley & Sons, 2016.
2. Sophocles J. Orfanidis, *Electromagnetic waves and antennas*, Rutgers University, 2016.
3. John D. Kraus, Ronald J. Marhefka, *Antennas for all Applications*, 3/e, TMH, 2002.
4. Thomas A Milligan,*Modern Antenna Design*, 2/e John Wiley & Sons, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of Antenna Parameters: Polarization, Input impedance, Gain. Relation between radiation fields and magnetic vector potential – Helmholtz equation and Lorentz conditions. Antenna matching – T match, baluns, gamma and omega match.	7
II	Review of dipole antennas (short dipole and arbitrary length), Monopole antennas, Vee and rhombic antennas. Folded dipole and its properties. Analysis of Circular Loop andBiconical Antenna. Helical Antennas (normal mode and axial mode) – relation for far fields, radiation resistance and gain.	8
III	Current induced in a dipole antenna – Pocklington and Hallen's integral equations. Solution of Hallen's integral equation for current induced in a dipole antenna for delta gap model. Near fields of linear antennas, self and mutual impedance, arrays of parallel dipoles, Yagi-Uda antennas.	8
IV	Aperture antenna – Field equivalence principle. Radiation from open-ended wave-guides, horn antennas, horn radiation fields, horn directivity, optimum horn design, rectangular micro-strip antennas– Filed analysis and design	7
V	Parabolic reflector antennas, gain and beam width of reflector antennas, aperture-field and current- distribution methods, radiation patterns of reflector antennas, dual-reflector antennas, lens antennas-hyperbolic lens and zoned lens. Frequency independent antennas – Rumsey Principle – Spiral Antennas. Design of log periodic dipole arrays.	7
VI	Antenna arrays – General expression for array factor. Grating lobes. One dimensional arrays- Broad side, end fire and Chebyshev arrays. Concept of beam steering. Design of array using Schelkunnoff's zero placement method and Fourier series method. Woodward-Lawson frequency-sampling design, Narrow beam design and Butler matrix beam former. Adaptive Beam forming. 2D arrays – Rectangular and Circular array.	8
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P60F	Wireless Communication and Networks	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The objective of this course is to provide a comprehensive understanding of radio propagation characteristics, design of cellular system, link design in satellite communication and to familiarize wireless networks.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO1	Analyse the performance of digital modulation schemes over wireless channel.	Analyse
CO 2	Explain various wireless channel models.	Understanding
CO 3	Analyse the performance of cellular systems.	Analyse
CO 4	Design satellite link.	Apply
CO 5	Compare wireless networks.	Analyse

iii) SYLLABUS

Propagation characteristics of radio waves, modulation and coding techniques for mobile radio, Space time propagation and channel models, capacity and diversity of space time channels. Cellular architecture and frequency allocation techniques for mobile radio, analysis of CDMA systems, Satellite link and interference analysis, wireless networks and standards.

iv) REFERENCES

1. T.S. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2002.
2. Tri. T. Ha, *Digital Satellite Communication*, 2nd Edn, McGraw Hill, 2009.
3. Paulraj, R. Nabar& D. Gore, *Introduction to Space Time Wireless Communications*, Cambridge University Press, 2003.
4. Andrea Goldsmith, *Wireless Communication*, Cambridge University Press, 2005.
5. G.L. Stuber, *Principles of Mobile Communications*, Kluwer Academic, 1996.
6. Kumar, D. Manjunath and J. Kuri, *Communication Networking, an Analytical Approach*, Elsevier, 2004.
7. C Sivarama Murthy and B S Manoj, *Ad-Hoc Wireless Networks, Architectures and Protocols*, PH, 2004.
8. 8. P. Muthu ChidambaraNathan, Wireless Communications, Prentice Hall, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Radio Propagation Characteristics: Models for path loss, shadowing and multipath fading (delay spread, coherence band width, coherence time, Doppler spread), Jakes channel model, Linear and constant envelope digital modulation techniques for mobile radio, Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Subchannels-OFDM, MC-CDMA.	**9**
II	Space time propagation: Wireless channel as a space time random field, space time channel models, capacity of frequency flat deterministic MIMO channels, Transmit and receive antenna diversity.	**8**
III	The cellular concept: Frequency reuse, The basic theory of hexagonal cell layout, Capacity of cellular system, Channel allocation schemes, Frequency planning techniques, Cluster planned hierarchical architecture.	**7**
IV	Cellular CDMA system: reverse and forward link, Radio Resource Management: soft and hard handoffs, CDMA soft handoff analysis, GSM cellular standards.	**7**
V	Satellite link: Basic link and interference analysis, Rain induced attenuation and cross polarization interference – link design, Frequency Division Multiple Access – FDM – FM – FDMA, Single channel per carrier.	**7**
VI	Wireless networks: IEEE 802.11 – Physical layer – media access frame format –802.11b, High throughput WLAN (IEEE 802.11n), Quality of service support (IEEE 802.11e), Security enhancements (IEEE 802.11i). Bluetooth, Bluetooth protocol architecture, Operational states, Bluetooth security, Mobile IP-Address mobility, Tunnelling, Handoffs, IPV6 advancements.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P62A	Adaptive Signal Processing	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The course is designed to provide students a good background in the concept of adaptive signal processing and apply it to the signals which can process adaptively.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Describe basic concepts of adaptive signal processing.	Understand
CO 2	Apply various adaptive filtering algorithms.	Apply
CO 3	Analyse the convergence aspects and computational complexity in adaptive filtering.	Analyse
CO 4	Explain the use of adaptive filtering for practical applications.	Understand

iii) SYLLABUS

Introduction to adaptive signal processing, Adaptive systems- definitions and characteristics. Smoothing and Prediction filtering, MSE predictors, Filtering, surface-stability and rate of convergence LMS and RLS algorithms and their tracking performance, Applications of adaptive signal processing.

iv) REFERENCES

1. Ernard Widrow and Samuel D. Stearns, *Adaptive Signal Processing*, Pearson Education, 2005.
2. Simon Haykin, *Adaptive Filter Theory*, 5th Edition Upper Saddle River, NJ:Pearson, 2014.
3. John R. Treichler, C. Richard Johnson, Michael G. Larimore, *Theory and Design of Adaptive Filters*, Prentice-Hall of India, 2002.
4. S. Thomas Alexander, *Adaptive Signal Processing - Theory and Application Adaptive Signal Processing: Theory and Applications* (Monographs in Computer Science) , Springer Science & Business Media (Springer-Verlag), 2012.
5. D. G. Manolakis, V. K. Ingle and S. M. Kogon, *Statistical and adaptive signal processing: spectral estimation, signal modeling, adaptive filtering, and array processing*, McGraw-Hill Education, 2000.

v) COURSE PLAN

Module	Contents	No. of hours
I	Goal of adaptive signal processing, some application scenarios, problem formulation. Adaptive systems - definitions and characteristics - applications – properties examples - adaptive linear combiner-input signal and weight vectors - performance function-gradient	**7**
II	MMSE predictors, LMMSE predictor, orthogonality theorem. Introduction to filtering-smoothing and prediction - linear optimum filtering - orthogonality - Wiener – Hopf equation-performance surface, Least square filters.	**8**
III	Searching performance surface-stability and rate of convergence - learning curve-gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty -variance - excess MSE and time constants	**8**
IV	Convergence of weight vector-LMS/Newton algorithm - properties - sequential regression algorithm - lattice structure - adaptive filters withorthogonal signals– mis-adjustments.	**8**
V	Adaptive recursive filters - RLS recursions - assumptions for RLS - convergence of RLS coefficients and MSE.LMS and RLS filters using lattice filters - Levinson Durbin algorithm - reverse Levinson Durbin algorithm. Tracking performance of LMS and RLS filters - Degree of stationarity and mis adjustment - MSE derivations.	**8**
VI	Adaptive modelling of Multipath Communication channel - Adaptive equalization of telegraph channels - Adaptive interference cancellation - Techniques used in Adaptive removal of noise in speech signals and echoes in long distance telephone circuits.	**6**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P62B	Digital Microwave Communication	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The goal of this course is to provide an insight to the students on the transmission, Equalisation, Bit stream integration in Digital Transmission Systems.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Discuss the structure of digital microwave Communication systems.	Understand
CO 2	Describe about the digital transmission systems.	Understand
CO 3	Explain the various Equalization techniques used in communication.	Understand
CO 4	Apply the concept of Bit Stream integration in Digital Transmission systems.	Apply
CO 5	Explain about waveguide components and Accessories.	Understand

iii) SYLLABUS

Digital Microwave Communication systems, Structure of 30 channel Primary MUX, Signalling in Telecommunication, R2 Signalling, Equalization techniques in DMR, Bit Stream integration in Digital Transmission systems, Waveguide components, Waveguide Accessories.

iv) REFERENCES

1. P V Sreekanth*: Digital Microwave Communication Systems, Universities Press,* 2003.
2. George Kizer, *"Digital Microwave Communication: Engineering Point –to – Point Microwave Systems," Wiley –IEEE Press.1st edition 2013.*
3. Robert E. Collin*: Foundation for Microwave Engineering,2nd edition*, McGraw Hill,2007.
4. David M. Pozar*: Microwave Engineering, 4th Edition, John Wiley & Sons, 2013.*
5. *Harvey Lahpamer, "Microwave Transmission Networks: Planning, design, and development,"* 2ndEdn, Tata McGraw-Hill, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Digital Microwave Communication systems - general block diagram, interconnections, 34+2Mb Digital microwave radio equipment – arrangement of modules – DMR 770, signal flow, modules and sub modules, Transmitter – Receiver sub system, Channel Primary MUX – Data frame.	**9**
II	Structure of 30 channel Primary MUX, Signalling in Telecommunication, R2 Signalling, and PDM 30B exchange. III order multiplexing equipment– 2/34 MUX equipment, overview of 2/8 card, 8/34 card (No detailed functional description), alarms and consequent action.	**8**
III	Equalization techniques in DMR-770 Digital Microwave radio – Delay equalizer, Transversal equalizer, line equalizer.	**7**
IV	Bit Stream integration in Digital Transmission systems – Multiplexing of synchronous data signals, multiplexing asynchronous signals, retiming by justification, perforated Clock, Integration of 2Mb streams in II order digital MUX, Integration of digital streams of different data rates.	**9**
V	Waveguide components – bands, corners, taper, twist, flexible wave guide, loading elements, ferrite devices	**6**
VI	Waveguide Accessories – clamps, earthing pit, flanges and coupling, bending tools, Precautions while hoisting waveguide.	**6**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P62C	Embedded Systems for Communication	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The goal of this course is to introduce the concepts of embedded systems, overview of the different communication buses and protocols and real time operating systems. It also introduces various computational models to design embedded system applications.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the architecture of ARM processors, 8051 and PIC.	Understand
CO 2	Describe processor and memory organization in an Embedded system.	Understand
CO 3	Explain the different standard communication protocols used in embedded systems.	Understand
CO 4	Illustrate the various computational models of the operations in a given embedded system.	Apply
CO 5	Explain various types of services and subsystems in RTOS.	Understand
CO 6	Design applications in telecommunication using ARM processors.	Apply

iii) SYLLABUS

Review of the microcontrollers- Memory Organization, Interrupts. Introduction to Embedded Systems - Characteristics, software, I/O devices, Interrupt Servicing mechanisms. Overview of Communication Buses and protocols. Hardware Software Co-design and Program Modelling. Real Time Operating Systems. Study of - VX works, MicroC/OS-II RTOS.

iv) REFERENCES:

1. K.V. Shibu, *Introduction to Embedded Systems*, 2e, McGraw Hill Education India, 2016.
2. Wayne wolf, *Computers as Components: Principles of Embedded Computing System Design*,Morgan Kaufmann; 2 ed,2008.
3. Lyla B. Das, 1/e, Lyla B. Das, *Embedded Systems: An Integrated Approach*, 2012.
4. Rajkamal, *Embedded Systems Architecture; Programming and Design*, 3rd Edition; Tata McGraw Hill Publications, 2017.
5. J.R.Gibson, *ARM Assembly Language –An Introduction*, Lulu Press, 2010
6. Jane.W.S. Liu,*Real-time Systems*, Pearson Education India 2002.
7. Phillip A Laplante: *Real-Time Systems Design and Analysis: An Engineer's Handbook*, 3rd edition, Wiley-IEEE,2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	Brief review of the microcontrollers – 8051/PIC/ARM - Programming, CPU Block diagram, Memory Organization, Interrupts, ADC, PWM, Timers, Watch Dog Timer, Serial Port, I/O Port.	8
II	Introduction to Embedded Systems: Characteristics of Embedded systems, Software embedded into a system - General ideas of Processor and Memory organization - Processor and memory selection, Interfacing to Memory and I/O devices- Devices and Buses- Device Drivers and Interrupt Servicing mechanisms.	8
III	Overview of Communication Buses and protocols – Serial Bus Communication Protocols, Parallel Bus Protocols, Internet Embedded Systems - Network Protocols, Wireless and Mobile System Protocols	7
IV	Hardware Software Co-design and Program Modelling – Program Models, Multiprocessor Systems, UML Modelling, Inter-process Communication and Synchronization of Processes, Tasks and Threads Multiple Processes in an Application - Data sharing by multiple tasks and routines- Inter Process Communication.	7
V	Real Time Operating Systems - Operating System Services, I/O Subsystems- Network Operating Systems - Real Time and Embedded System Operating systems -Interrupt routines in RTOS Environments - RTOS Task Scheduling models, Interrupt Latency and response Times - Standardization of RTOS - Ideas of Embedded Linux.	8
VI	Study of VX works, MicroC/OS-II RTOS, Case Studies of programming with RTOS and Case study /design using 8051/PIC microcontroller/ARM processor for applications in Telecommunications.	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P62D	Advanced Coding Theory	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: Goal of this course is to expose the need for coding theory in the field of communication, computations in Galois field and Extended Galois field and to apply the basic concept of generation and detection of the algebraic codes and Iterative codes in the design of high performance systems

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Perform operations in Galois field and its Extended field.	Apply
CO 2	Explain the concept of various theorems related with algebraic codes and iterative codes.	Understand
CO 3	Apply the basic error detection and correction mechanisms for reliable data transmission	Apply
CO 4	Design encoder and decoder for various coding schemes	Apply
CO 5	Analyse the performance of various coding schemes	Apply

iii) SYLLABUS

Arithmetic operations in GF(2) and GF(2^M), Primitive polynomials and Minimal polynomials, linear block codes, generation and detection of Cyclic codes – error trapping decoding, Golay Code, Kasami code, Iterative codes, cyclic hamming code.

BCH Codes - Generation of Primitive and Non-primitive BCH code with binary arithmetic, RS Code generation and Decoding, Berlekamp algorithm.

Generation and detection of Convolutional codes – in ARQ systems, LDPC and Turbo codes.

iv) REFERENCES

1. Shu Lin & Daniel J. Costello.Jr., *Error Control Coding : Fundamentals and Applications*, 2/e,Prentice Hall Inc.,Englewood Cliffs, NJ,2011
2. Man Young Rhee, *Error Correcting Coding Theory*, 1989, McGraw-Hill
3. GravanoSalvatore, *Introduction to Error Control Codes*, Oxford University Press, 1st Ed., 2007.
4. Todd K.Moon, *Error Correction Coding – Mathematical Methods and Algorithms*, 2006, Wiley India.

v) COURSE PLAN

Module	Contents	No. of hours
I	Binary Arithmetic: Groups, Field, Binary Field Arithmetic, Construction of Galois Field GF(2M), Basic properties of GF(2M), Computations using Galois Field GF(2M) Arithmetic. Primitive polynomials and Minimal polynomials in GF(2) and GF(2M).	**7**
II	Linear Block codes: Minimum distance, Error detection and correction capability, Standard Array – Syndrome decoding, Probability of undetected error for LBC over BEC.	**7**
III	Cyclic Codes: Generator and Parity Check matrices of cyclic codes, Syndrome Computation and Error detection, Cyclic hamming codes, Shortened cyclic codes. Error trapping decoding for cyclic codes, Golay Code, Kasami Decoder, Systematic Search decoder.	**8**
IV	Algebraic Codes: BCH Codes - Generation of Primitive and Non-primitive BCH code with binary arithmetic. Single and Double – error correcting BCH codes. Parity Check matrix. Decoding of BCH codes – Iterative algorithm for the computation of error location polynomial, Error detection and Correction.RS Code generation and Decoding, Berlekamp algorithm.	**8**
V	Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system.	**8**
VI	LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P63A	Information Theory	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The goal of this course is to introduce the concepts of entropy, its properties and significance in source coding, to familiarize the concept of channel capacity, its computation and rate distortion theory.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Analyze the Entropy for discrete and continuous random variables.	Analyse
CO 2	Apply the different source coding techniques in a communication system.	Apply
CO 3	Analyze practical lossless data compression techniques with varying efficiencies.	Analyse
CO 4	Compute the capacity of discrete and continuous channels and find the ways to achieve the capacity.	Apply
CO 5	Explain the rate distortion theory.	Understand

iii) SYLLABUS

Entropy for discrete and continuous random variables and its properties, source coding theorem and its significance. Importance of typical set in source coding techniques, computation of channel capacity, Channel coding theorem, Different channels, Introduction to rate distortion and its properties.

iv) REFERENCES

1. Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, Wiley India Pvt. Ltd., 2nd Edition 2013.
2. Robert Gallager: *"Information Theory and Reliable Communication*", John Wiley & Sons.1972.
3. Shu Lin and Daniel. J. Costello Jr.: *"Error Control Coding: Fundamentals and applications",* 2nd edition, Prentice Hall Inc, 2002.
4. Abbas El Gamal, Young-Han Kim, *Network Information Theory*, Cambridge University Press 2011
5. T. Bergu: *"Rate Distortion Theory a Mathematical Basis for Data Compression"* PH Inc. 1971.
6. Special Issue on Rate Distortion Theory, IEEE Signal Processing Magazine, Vol. 15, No. 6, November 1998.
7. R. J. McEliece: *"The theory of information & coding",* Addison Wesley Publishing Co.1982.

v) COURSE PLAN

Module	Contents	No. of hours
I	Entropy- Memory less sources- Markov sources- Entropy of a discrete Random variable- Joint, conditional and relative entropy- Mutual Information and conditional mutual information- Chain relation for entropy, relative entropy and mutual Information.	**8**
II	Lossless source coding- Uniquely decodable codes- Instantaneous codes- Kraft's inequality - Optimal codes- Huffman code- Shannon's Source Coding Theorem, Lempel Ziv Coding.	**7**
III	Asymptotic Equipartition Property (AEP) - High probability sets and typical sets- Properties of typical set - Data compression.	**7**
IV	Channel Capacity- Capacity computation for some simple channels, Jointly Typical Sequences, Fano's inequality- Shannon's Channel Coding Theorem, Converse- Channels with feedback- Joint source channel coding Theorem.	**8**
V	Differential Entropy- Joint, relative and conditional differential entropy- Mutual information. Gaussian channels- Band limited channels- Shannon limit- Parallel Gaussian Channels- Water filling.	**8**
VI	Rate distortion theory - Introduction, Quantization, Rate distortion function, calculation, continuous sources and rate distortion measure, Rate distortion theorem, converse, information transmission theorem.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P63B	Image and Video Processing	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES

The course aims to introduce the basic mathematical concepts and techniques required for 2D signal processing, different image processing techniques, different video processing operations and various image and video compression techniques.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Analyze two dimensional signals in time and frequency domain.	Analyse
CO 2	Apply various image enhancement and segmentation techniques.	Apply
CO 3	Illustrate various restoration and reconstruction techniques.	Apply
CO 4	Explain the Basic of Video Processing.	Understand
CO 5	Explain the compression standards of Image and Video Processing.	Understand

iii) SYLLABUS

Basics of Image processing, Image transforms, Image enhancement, Image Segmentation, Image texture analysis, Image Restoration, , Image Reconstruction from projections.
Basic Steps of Video Processing, Motion Estimation, Video processing operations, Image compression and standards, Video compression and standards.

iv) REFERENCES:

1. Rafel C Gonzalez and Richard F Woods, *Digital Image Processing*, 4th edition, Pearson Education, 2018.
2. S Jayaraman, S Esakkirajan and T Veerakumar, *Digital image processing*, Tata McGraw Hill, 2015.
3. A. Murat Tekalp, *Digital video Processing*, Prentice Hall International, Prentice Hall, 2nd edition, 2015
4. Jain Anil K , *Fundamentals of digital image processing* , PHI, 1988
5. Kenneth R Castleman, *Digital image processing*, Pearson Education, 2/e, 2003.
6. Pratt William K, *Digital Image Processing*, John Wiley, 4/e, 2007.

7. Rafel C Gonzalez, Richard F Woods and Steven L Eddins, *Digital Image Processing using MATLAB*, 4/e, Pearson Education, 2020.
8. Yao wang, JornOstermann and Ya-quin Zhang, *Video processing and communications*, PHI,2017.
9. BhabatoshChanda, D. DuttaMajumder: *Digital Image Processing and Analysis*, PHI, Second edition 2011.
10. Alan C. Bovik, *Handbook of Image and Video Processing*, Academic Press, 2nd edition, Academic Press, 2010 .
11. Keith Jack, Video Demystified: *A Handbook for the Digital Engineer*, Newness Publisher 5th Edition 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	Basics of Image processing, RGB and HSV colour model, 2D sampling theorem and Nyquist criteria, Interpolation, Moire Effect and flat field response. Image transforms - DFT, DCT, Sine, Hadamard, Haar, Slant, KL transform, Wavelet transform.	**8**
II	Image enhancement**:-**Point processing, Spatial filtering, Histogram techniques, Pseudo colouring and false colouring, Frequency filtering. Image Restoration: - Image observation models, Sources of degradation, inverse filtering and wiener filtering.	**8**
III	Image Segmentation**: -** region growing, region merging and split and merge, watershed segmentation. Image texture analysis - co-occurrence matrix, measures of textures, statistical models for textures.	**7**
IV	Hough Transform, boundary detection, chain coding, Image Reconstruction from projections: - Random transform, Back-projection operator, Back projection algorithm, Fan beam and algebraic restoration technique.	**8**
V	Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models: 3D motion models, Geometric Image formation, Photometric Image formation, sampling of video signals, filtering operations 2-D Motion Estimation: Optical flow, general methodologies, Block matching algorithm, global Motion Estimation. Application of motion estimation in video coding.	**7**
VI	Video processing operations– display enhancement, video mixing, video scaling, scan rate conversion, Image compression – lossless and lossy compression techniques, standards for image compression – JPEG, JPEG2000. Video compression- intra and interframe prediction, perceptual coding, standards - MPEG, H.264.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P63C	High Performance Communication Networks	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The course aims to familiarize network architectures, protocols and understand the core networking principles and technologies from a system perspective.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the principles of high speed communication.	Understand
CO 2	Describe digitization, network elements and network mechanisms.	Understand
CO 3	Explain the core networking principles and technologies from a system perspective.	Understand
CO 4	Analyse the categories and topologies of high-performance networks.	Analyse

iii) SYLLABUS

Principles of High-speed networking. Service Integration - architecture, characterization and mechanisms.

Packet Switched Networks. Internet and TCP/IP Networks. Circuit switched networks, ATM and Wireless Networks**.**

iv) REFERENCES

1. Jean Walrand and PravinPratapVaraiya, *High Performance Communication Networks, 2nd Edition*, Harcourt and Morgan Kauffman, London, 2000.
2. SumitKasera, *ATM Networks, Tata McGraw-Hill, New Delhi, 2006.*
3. Behrouz.a. Forouzan, *Data Communication and Networking, Tata McGraw*-Hill, New Delhi, 2001.
4. C.SivaramMurty and M.Guruswamy, *WDM Optical Networks, Concepts, Design and Algorithms*, PHI,2002.
5. A.LeonGracia,I. Widjaja, *Communication networks , Tata McGraw-Hill, 2nd edition*,New Delhi, 2006.
6. Rajiv Ramaswamy,KumarSivarajan, *Optical Networks:a practical perspective*, 2nd edition,Morgan Kaufmann, 2002.

v) COURSE PLAN

Module	Contents	No. of hours
I	Basics of Networks:-Principles of High speed networking. Integration of -Telephone, computer, Cable television and Wireless network.	**7**
II	Digitalization: Service integration, network services and layered architecture, traffic characterization and QoS, networks, services: network elements and network mechanisms.	**8**
III	Packet Switched Networks:-OSI and IP models: Ethernet (IEEE 802.3); token ring (IEEE 802.5), FDDI, DQDB, frame relay, SMDS: Internet working with SMDS.	**7**
IV	Internet and TCP/IP Networks:-Overview; Internet protocol; TCP and VDP; performance of TCP/IP networks. Circuit switched networks: SONET; DWDM, Fibre to home, DSL, Intelligent networks, CATV.	**7**
V	ATM and Wireless Networks:-Main features-addressing, signalling and routing; ATM header structure- adaptation layer, management and control; BISDN; Internet-working with ATM, Wireless channel, link level design, channel access; Network design and wireless networks.	**8**
VI	Optical Networks and Switching:-Optical links- WDM systems, cross-connects, optical LAN's, optical paths and networks; TDS and SDS: modular switch designs-Packet switching, distributed, shared, input and output buffers.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P63D	Digital System Design	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: This course introduces students to the ideas of advanced design and analysis of digital circuits. It provides in depth understanding of digital system design using hardware description languages. It enables the students to design advanced digital circuit hardware using EDA tools.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Design combinational and sequential circuits	Apply
CO 2	Design synchronous and asynchronous sequential circuits.	Apply
CO 3	Describe the FPGA architecture and its application	Apply
CO 4	Design digital circuit with SM chart	Apply
CO 5	Implement HDL based design flow of digital circuits in FPGA	Apply

iii) SYLLABUS

Introduction to Digital Systems Design, Design of combinational and sequential circuits, Sequential

Circuit Design, Asynchronous sequential circuits, FPGA architecture, Designing with SM charts,

VHDL Basics and HDL based design flow

iv) REFERENCES

1. Charles H Roth Jr , Digital Design using VHDL, Cenage Publishers, India Edition,2006.
2. J. Bhasker; A VHDL Primer, Pearson Education, 2000.
3. N.N Biswas, Logic Design Theory, Prentice Hall of India, 1st Edn.
4. Charles H. Roth, Fundamentals of Logic Design, Thomson Publishers, 5th edition.
5. Milos D Ercegovac, Tomas Lang, Digital systems and hardware / firmware algorithm, John Wiley, 1985.
6. Digital Design Fundamentals", Kenneth J Breeding, Prentice Hall, Englewood Cliffs, New Jersey.
7. John F Wakerly, Digital Design Principles and Practice –4th Edition, Pearson education, 2006

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Digital Systems Design: Design of combinational and sequential circuits using ROMs, PALs and PLAs, Arithmetic PAL devices – Study based on PAL22V10	**7**
II	Sequential Circuit Design: Clocked Synchronous State,Machine Analysis, Mealy and Moore machines. Finite State Machine design procedure – derive state diagrams and state tables, state reduction methods, and state assignments. Design examples using the FSM approach –sequence detector, serial adders, multipliers	**8**
III	Asynchronous sequential circuits: Analysis, Derivation of Excitation table, Flow table reduction, State assignment,Transition table,Design of asynchronous Sequential circuits, Race conditions and cycles, Static and dynamic hazards, Essential hazards, Methods for avoiding races and hazards.	**8**
IV	FPGA architecture – RAM based FPGAs - Antifuse FPGAs - Selecting FPGAs – CLBs, Input/output Blocks - Programmable Interconnect (study based on Xilinx FPGAs only). Dedicated Specialized Components of FPGAs, Applications of FPGAs	**8**
V	Designing with SM charts– State machine charts, Derivation of SM charts and Realization of SM charts. Implementation of BinaryMultiplier, dice game controller.	**7**
VI	VHDL Basics - Introduction to HDL - Behavioral modeling - Data flow modeling- Structural modeling - Basic language elements, HDL based design flow.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P68B	Telecommunication Lab-II	PCC	0	0	2	1	2020

i) COURSE OBJECTIVES: The goal of this course is to expose the students to the simulation of digital communication systems, generate and analyse spread spectrum sequences and error correction codes and simulate radiation patterns of antennas and wireless network system.

ii) COURSE OUTCOMES

Course Outcomes	Description	Level
CO 1	Design simple digital communication systems over AWGN channels and fading multipath channels.	Apply
CO 2	Design spread spectrum communication systems using ML and gold sequence .	Apply
CO 3	Design channel codes with error correction using convolutional codes like Hamming and Turbo codes .	Apply
CO 4	Design radiation patterns of antennas based on given specifications.	Apply
CO 5	Design wireless network system involving packet based physical layer and data link layer.	Apply

iii) LIST OF EXERCISES / EXPERIMENTS

Tools:Numerical Computing Environments – GNU Octave, - MATLAB, Communication Block set, RFBlock set and signal processing Block set, NS2/OPNET.

Channel Coding: Linear Block code and Convolutional codes -Viterbi Decoding – Majority LogicDecoders- CRC-32.

Modeling and Simulation of Radio Channels - Multipath Fading Channels- Jake‟sModel. Spread Spectrum Communication Systems

Scheduling and Queuing Disciplines in Packet Switched Networks: FIFO, Fair Queuing.

RED- TCP Performance: with and without RED.

Antenna simulation: using ANSYS, IE3D and Microsoft office. OMNET++.

Wireless Medium Access Control: MAC layer 802.11: CSMA/CA, RTS/CTS mode.

Simple Ad hoc/Sensor Networks: Simulation and Evaluation.

iv) REFERENCES

1. Stephen J. Chapman, *MATLAB Programming for Engineers*, 2007.
2. O. Beucher, M. Weeks, *Introduction to MATLAB & SIMULINK (A Project Approach)*, 3/e, 2008

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P69B	Mini Project	PWS	0	0	4	2	2020

i) COURSE OBJECTIVES:

Goal of this course is to enable students to take up small problems in their field of study as mini project and collect the recent publications related to the topic and present the observations and findings related to the project work

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Implement a designed system or application by identifying and solving problems in the field of study.	Apply
CO 2	Test the designed system or application.	Evaluate
CO 3	Develop effective written and oral communication	Create
CO 4	Explore domains of interest so as to pursue the course project.	Analyse

iii) APPROACH

1) Students shall make a presentation for 20-25 minutes based on the detailed study on the project and submit a report of the study.
2) There will be two interim progress review of the Mini project work. The first review will focus on the topic, objectives, methodology, design and expected results.

SEMESTER – III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P71A	Neuro Fuzzy Systems	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: The objective of this course is

- Explore the basic principles underlying the analysis and synthesis of fuzzy neural integrated systems with models and case studies.
- Focuses on the usage of heuristic learning strategies derived from the domain of neural network theory to support the development of a fuzzy system.
- Deals with the fundamentals of genetic algorithms for neural-net training and structure optimization, issues involved and their applications in a variety of different areas of engineering and science.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Describe a framework for unification, construction and development of neuro-fuzzy systems.	Understand
CO 2	Analyze theoretical and practical problems by effective development of models.	Analyze
CO 3	Apply genetic algorithms in the solution of optimization problems.	Apply

iii) SYLLABUS

Learning processes, Single layer and Multi layerPerceptrons, Principal Component Analysis, Independent Component Analysis, Stochastic Machines, Neurodynamics, Neuroprogramming, Fuzzy systems, Neuro-fuzzy systems, Genetic Algorithms, Convergence rate, case studies.

iv) REFERENCES:

1. Simon Haykin, Neural Networks, a comprehensive foundation, 2/e, Pearson Education.
2. Timothy J Ross, Fuzzy logic with Engineering Applications" 3/e, McGraw Hill
3. John Yen, Reza Langari, Fuzzy Logic-Intelligence, Control and Instrumentation, Pearson Education, 2002
4. YegnaNarayana B, Artificial Neural Networks– PHI

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Neuro-Fuzzy systems – models of neuron, Neural network architectures, Learning processes – algorithms. Learning paradigms. Single layer perceptrons, Perceptron Convergence theorem.	**8**
II	Multilayer perceptrons – architecture, back-propagation algorithm. XOR problem. Principles of self-organized learning. Principal Component analysis – data representation, dimensionality reduction. Independent Component analysis.	**8**
III	Stochastic Machines – Metropolis algorithm, Simulated annealing, Gibbs sampling, Boltzmann machine. Neurodynamics – Hopfield models, Cohen-Grossberg theorem, Brain-state-in-a-box model.	**8**
IV	Fuzzy systems, operations on fuzzy sets, fuzzy relations, Fuzzy tolerance and equivalence relations, Fuzzification and Defuzzification– centroid method.	**8**
V	Classical and fuzzy predicate logic, Fuzzy rule-based systems, fuzzy pattern recognition, Fuzzy control systems, Case study – inverted pendulum.	**8**
VI	Genetic Algorithms and Fuzzy Logic, Basics, Design issues, Improving the Convergence rate, Genetic Algorithm methods, Case studies.	**5**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P71B	Secure Communication	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES: Goal of this course is to have an understanding of the basics of number theoretic methods and the applications of algorithms used in classical and modern cryptography and their cryptanalysis.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the number and abstract algebra which develops the mathematical proof writing skills.	Understand
CO 2	Describe the characteristics of the different elementary algebraic structures.	Understand
CO 3	Apply the various classical cryptography ciphers and the cryptographic standards.	Apply
CO 4	Apply the various algorithms used in cryptanalysis.	Apply

iii) SYLLABUS

Introduction to cryptography - classification, Computational Complexity theory - Classes, Number theory, congruences and related theorems- Linear Diophantine equations, Quadratic residues, Legendre symbol, Elementary Algebraic Structures, Elliptic Curves, Classical Cryptographic techniques, Public key Cryptographic techniques, Cryptographic standards, Cryptanalysis Algorithms, Primality test, Integer Factorization, Algorithms for Discrete Logarithms

iv) REFERENCES

1. A Course in Number Theory and Cryptography, Neal Koblitz, Springer, 3/e, 2012.
2. Fundamentals of Cryptology, Henk CA van Tilborg, Kluwer Academic Publishers, 3/e, 2006.
3. Number Theory for Computing, Song Y Yan, Springer, 6/e, 2014.
4. Elementary Number Theory with Applications, Kenneth H. Roshan, Pearson, 6/e, 2010.
5. Primality Testing and Integer Factorization in Public Key Cryptography, Song Y Yan, Springer, 2/e, 2013.
6. Public Key Cryptography, ArtoSalomaa, Springer, 2/e, 2012.
7. An Introduction to Theory of Numbers, I Niven, HS Zuckerman, John Wiley and Sons, Wiley, 9/e, 2000.
8. How to Prove it-A structured Approach, Daniel J Velleman, Cambridge University Press, 2/e, 2006.
9. G. H. Hardy, E. M. Wright, An Introduction to Theory of Numbers, Oxford University Press, 4/e, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to cryptography - stream and block ciphers- symmetric and public keys. Basics -Mathematical proofs and methods. Complexity theory: Computational Complexity Classes P, NP- NPComplete, NP-Hard, BPP. Number theory: primes, divisibility, congruences, systems of congruence equation, quadratic congruences. Linear Diophantine equations, Wilson theorem, Fermat's little theorem, Euler's theorem. Multiplicative functions, Primitive roots, Quadratic residues, Legendre symbol, Continued fractions.	**9**
II	Elementary Algebraic Structures: Groups- subgroups, order, homomorphism, cyclic groups, generators. Rings- characteristics, Finite Fields. Polynomial Rings and their algebra over finite fields, multiplicative inverses. Discrete logarithm over groups. Elliptic Curves: as a group defined over finite field, number of points, order and algebra of rational points on elliptic curves.	**8**
III	Classical Cryptography: Affine ciphers, hill ciphers, digraphs, enciphering matrices.; Linear Feedback Shift Registers for PN sequences. Public key Cryptography: One way functions, Hash functions, Knapsack cryptosystems.	**7**
IV	RSA, DeffieHelman Key Exchange system, El Gamal's Public key crypto system. Elliptic curve crypto system. Cryptographic standards: DES, AES, MD5, Digital Signature, Zero Knowledge Protocol.	**6**
V	Cryptanalysis. Algorithms : Modular exponentiation, Fast group operations on Elliptic curves. Primality test- Fermat’s pseudo primality test, Strong prime test, Lucas Pseudo prime test, Elliptic curve test.	**7**
VI	Integer Factorization- Trial division, Fermat's method, CFRAC. Quadratic and Number Field Sieves. Algorithms for Discrete Logarithms: Baby-step Giant-step alg. Algorithms for Discrete Logarithm on Elliptic curves.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P71C	Space Time Coding and MIMO Systems	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

To introduce various aspects of MIMO communication systems for wireless broadband networks, MIMO channel models, space time block codes and trellis codes.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO1	Derive the capacity of various types of MIMO channels.	Apply
CO 2	Analyze the Space Time transmit and receive diversity under different fading conditions.	Analyze
CO 3	Analyze the performance of a MIMO system.	Analyze
CO 4	Apply the appropriate space Time Block and Trellis codes in a MIMO system.	Apply

iii) SYLLABUS

Review of SISO communication, MIMO channels, Multidimensional channel modelling, Capacity of MIMO channels, Diversity, Diversity methods, Combining methods, Space-time code design criteria, Orthogonal space, Maximum-likelihood decoding and maximum ratio combining, Quasi-orthogonal space-time block codes, Space time trellis codes, Spatial multiplexing and receiver design, Using equalization techniques in receiver design, Combined spatial multiplexing and space-time coding, MIMO OFDM.

iv)REFERENCES:

1. Paulraj, R. Nabar and D. Gore, Introduction to Space Time Wireless Communications, Cambridge University press, 2008.
2. B.Vucetic and J. Yuan, Space-Time Coding, John Wiley, 2003.
3. E.G. Larsson and P. Stoica, Space-Time Block Coding for Wireless Communications, Cambridge University press, 2008.
4. H. Jafarkhani, Space-Time Coding: Theory and Practice, Cambridge University press,2005.
5. D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University press, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of SISO communication- MIMO channel models Transmission model for MIMO channels, Multidimensional channel modeling, Capacity of MIMO channels, Outage capacity.	8
II	Diversity-Principle, array and diversity gains, Diversity methods, Combining methods-maximum ratio combining, selection combining.	7
III	Space-time code design criteria - Rank and determinant criteria, Trace criterion, Maximum mutual information criterion. Orthogonal space-time block codes – Alamouti code.	8
IV	Maximum-likelihood decoding and maximum ratio combining, orthogonal designs. Quasi-orthogonal space-time block codes-Pairwise decoding, Rotated QOSTBCs, Space time trellis codes.	8
V	Spatial multiplexing and receiver design-Introduction, Spatial multiplexing, Sphere decoding, Using equalization techniques in receiver design, V-BLAST , D-BLAST, Turbo-BLAST	7
VI	Combined spatial multiplexing and space-time coding, MIMO OFDM	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P71D	Advanced VLSI DSP Architectures	PEC	3	0	0	3	2020

i) COURSE OVERVIEW: This course introduces students to the basic ideas of multirate system and signal processing. It provides in depth understanding of adaptive system algorithm and transformation techniques to meet the constraints of digital design.

ii) COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Interpret multirate signal fundamentals and signal processing.	Apply
CO 2	Describe various adaptive signal processing algorithms.	Understand
CO 3	Analyse systolic design methodology.	Analyze
CO 4	Describe various pipeline architectures and parameters.	Understand
CO 5	Apply pipelining and parallel processing algorithm in digital design.	Apply
CO 6	Apply the knowledge of transformation techniques to optimize constraints in digital circuit design.	Apply

iii) SYLLABUS

Multirate system fundamentals, Applications of multirate signal processing, Adaptive Signal processing, Pipe lining and parallel processing, Transformations techniques-retiming, unfolding, folding, register minimization, Systolic Arrays, Fast convolution, Synchronous, wave and asynchronous pipelines.

iv) REFERENCES

1. Keshab K Parhi, VLSI DSP Systems- Design and Implementation – John Wiley, 2007.

2. LjiljanaMilić , Multirate Filtering for Digital Signal Processing - MATLAB applications,Information Science Reference, 2009.

3. Bernard Widrow & Samuel D. Stearns, Adaptive Signal Processing, Pearson Education, 2009.

4. N J Fliege, Multirate Digital Signal Processing, John Wiley 1999.

5. P PVaidyanathan ,Multirate Systems And Filter banks, Pearson Education, 2008.

6. Emmanuel C Ifeachor, Barrie W. Jervis, Digital Signal Processing- A Practical Approach, Prentice Hall, 1993

v) COURSE PLAN

Module	Contents	No. of hours
I	**Multirate system fundamentals:** Basic Multirate operation – up sampling and down sampling, Time domain and frequency domain analysis, identities for multirate operations, Interpolator and decimator design, Rate conversion by non-integer factor, polyphase structures, applications of multirate signal processing.	8
II	**Adaptive Signal processing:** Adaptive systems, Open and Closed Loop Adaptation, Adaptive Linear Combiner, Adaptive Algorithms and structures – LMS algorithm, Ideal LMS, Newton Algorithm and its properties, Advantages and disadvantages of adaptive recursive filters – LMS algorithm for recursive filters, Random search algorithms.	8
III	**Systolic Arrays:** Systolic array design methodology, FIR Systolic arrays, selection scheduling vector, Matrix Matrix multiplications, 2 D systolic a design, Systolic design for space representations containing delays.	8
IV	**Synchronous, wave and asynchronous pipelines:** Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs, Wave pipelining, asynchronous pipelining.	7
V	**Pipe lining and parallel processing:** Pipe lining of FIR filters, Parallel processing, pipe lining and para processing for low power. Fast convolution – Cook Toom Algorit Modified Cook Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic convolution.	7
VI	**Transformations techniques:** Retiming- definitions and properties, retiming techniques, unfolding- algorithm for unfolding, properties of unfolding, critical path, unfold and retiming, applications of unfolding, folding- folding transformation, register minimization Techniques, register minimization in folded architectures.	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P72A	WDM Optical Network and Optical Switching	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The goal of this course is to expose the students to various components, layers, network survivability and control management of WDM networks. It enables the students to design a WDM network. Also the students get exposed to the concept of packet switching in an optical network.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the transmission basics, non-linearity issues and various components in WDM networks.	Understand
CO 2	Discuss the designing issues and solution in WDM networks.	Understand
CO 3	Apply the knowledge of WDM to model a network.	Apply
CO 4	Explain different optical layers, interfacing and control management employed in WDM networks.	Understand
CO 5	Explain the basics of packet switching and transmission layer modeling.	Understand

iii) SYLLABUS

Introduction to Optical Networks. Basics of optical Packet Switching and transmission. Networks:Client Layers of the Optical Layer. Introduction to WDM Network Elements. Control Management:Optical Layer services and Interfacing. Access Network: Photonic Packet Switching

iv) REFERENCES:

1. Ramaswami, Sivarajan, Optical Networks, 3rd edition, Elsevier – 2009.
2. C. Sivaramamurthy& M. Gurusamy, WDM optical Networks, PHI, 2002.
3. E.A.Saleh, M.C.Teich, Fundamentals of photonics-Part II, Wiley Interscience, 2019.
4. J. Singh, Optoelectronics: an introduction to materials and devices, McGraw Hill, 1996.
5. J. Wilson and J. F. B. Hawkes, Optoelectronics: an introduction, Prentice Hal.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Optical Networks: The Optical Layer, Transparency and All-Optical Networks.Optical Packet Switching.Transmission Basics: Propagation of Signals in Optical Fiber: Nonlinear Effects.	**6**
II	Components: Isolators and Circulators, Multiplexers and Filters,Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Convertors, Transmission System Engineering: System Model	**8**
III	Networks: Client Layers of the Optical Layer: SONET / SDH, ATM, IP, Storage Area Networks.	**7**
IV	WDM Network Elements: Optical Cross connects, WDM Network.Design, LTD and RWA Problems, Dimensioning Wavelength Rooting Networks, Statistical Dimensioning Models, Maximum Load Dimensioning Model, DWDM networks.	**8**
V	Control Management: Optical Layer services and Interfacing,Performance and Fault Management, Configuration Management.Network Survivability: Protection in SONET / SDH, Protection in IPNetwork, Optical Layer Protection Scheme	**8**
VI	Access Network: Photonic Packet Switching, Optical TDM, Synchronisation, Header Processing, Buffering, Burst switching,Deployment considerations, Designing transmission Layer.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P72B	RF MEMS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The goal of this course is to provide an insight to the students on the fundamentals of RF MEMS circuit elements, MEMS based circuit design.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Describe the different MEMS fabrication technologies.	Understand
CO 2	Determine the various actuation mechanisms used in MEMS devices.	Understand
CO 3	Explain the operation of RF MEMS switches, inductors and capacitors.	Understand
CO 4	Describe the working of RF MEMS Phase Shifters, Filters, Resonators, Oscillators.	Understand
CO 5	Discuss the concepts of micromachined antennas.	Understand

iii) SYLLABUS

Introduction to RF MEMS- application, fabrication. Introduction to Microfabrication Technique. RF MEMS switches and applications. Introduction to MEMS switch design and its analysis. Different types of inductors, capacitors and resonators. Introduction to Micromachined antennas and RF NEMS

iv) REFERENCES:

1.RF MEMS and Their Applications, Vijay Varadan, K. J. Vinoy, K. A. Jose, Wiley, 2003.

2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2017.

3. Chang Liu, Foundations of MEMS, Pearson 2012.

4. RF MEMS: Theory, Design, and Technology, Gabriel M. Rebeiz, Wiley, 2003.

5. RF MEMS Circuit Design for Wireless Applications, Hector J. De Los Santos, Artech House, 2002.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to RF MEMS, application in wireless communications; Overview of RF MEMS fabrication, design and testing.	**7**
II	Introduction to Micro fabrication Techniques- Materials properties, Bulk and surface micromachining, Wet and dry etching, Thin-film depositions; Actuation Mechanisms in MEMS- Piezoelectric, Electrostatic, Thermal, Magnetic	**7**
III	RF MEMS switches and applications, Integration and biasing issues for RF switches	**7**
IV	MEMS switch design, modelling and analysis- Electromechanical finite element analysis, RF design.	**8**
V	Inductors and capacitors - micro machined inductors, variable inductors, polymer based inductors, gap-tuning and area tuning capacitors, dielectric tunable capacitors.	**8**
VI	Resonators –applications in oscillators and filters. Micromachined antennas. RF NEMS-overview	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P72C	Radio Frequency System Design	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The goal of this course is to provide an insight to the students on the modelling of RF system design in the field of communication system.

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the RF circuits using S-parameters, Signal flow graphs and Smith charts.	Understand
CO 2	Discuss about first order filters, Frequency transformation and Impedance Transformation.	Understand
CO 3	Design BJT and MESFET Amplifiers.	Apply
CO 4	Design High Frequency Oscillators.	Apply
CO 5	Describe about RF Mixers.	Understand

iii) SYLLABUS

RF behaviour of passive Components, Scattering Parameters, Smith Chart and applications. ABCD parameters of simple Two Port Networks, RF Filter Design- First order low pass, high pass and band pass filter circuits.

Analysis of Tunnel Diode, Gunn Diode, Varactor Diode. Design of simple matching and biasing networks. Power relations for RF transistor and MESFET Amplifiers, Stabilization methods. Simple BJT and MESFET Amplifier Design Examples. High frequency Oscillator configuration, Design of MESFET based Oscillator, Dielectric resonator Oscillator, Gunn Oscillator,YIG Oscillator. Design of simple RF Mixer Circuit based on BJT and MESFET.

iv) REFERENCES:

1.David M Pozar,Microwave Engineering 4th edition. Wiley, 2011.

2.Reinhold Ludwig, PavelBretchko, RF Circuit Design-Theory and Application, 2nd edition Pearson Education, New Delhi, 2011.

3.Matthew M Radmanesh, Radio Frequency and Microwave Electronics, PearsonEducation, Asia 2006

4. John W. M. Rogers, Calvin Plett, Radio Frequency Integrated Circuit Design, Second Edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of transmission lines-Binomial and Chebyshev transformer. Return loss and Insertion loss. Smith chart - Impedance matching using smith chart. ABCD parameters of simple Two Port NetworksImpedance Element, T networks, Transmission line section (analysis not required). Scattering parameters – Chain scattering matrix, Signal flow analysis using S parameters.	**8**
II	RF Filter Design- First order low pass, high pass and band pass filter circuits. Frequency transformation and Impedance Transformation. Higher order filter design concepts	**8**
III	Review of BJT and MESFET. V-I Characteristics and High Frequency equivalent circuits. High Frequency equivalent circuits of Tunnel Diode, Gunn Diode, Varactor Diode. PIN Diode as an attenuator, Computation of transducer loss.	**7**
IV	Design of simple matching and biasing networks. Power relations for RF transistor and MESFET Amplifiers, Stabilization methods. Simple BJT and MESFET Amplifier Design Examples	**7**
V	Microwave Oscillators –High frequency Oscillator configuration, Design of MESFET based Oscillator, Dielectric resonator Oscillator, Gunn Oscillator, YIG Oscillator.	**8**
VI	Mixers-Design of simple RF Mixer Circuit based on BJT and MESFET.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P72D	Machine learning for Communication	PEC	2	1	0	3	2020

i) COURSE OBJECTIVES: The objective of this course is

- To familiarize the student with various classification techniques used in machine learning
- To solve real time problems using machine learning algorithms
- To apply machine learning algorithms for communication system applications

ii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Discuss the fundamental concepts of machine learning.	Understand
CO 2	Apply the concepts of linear regression with single and multiple variables.	Apply
CO 3	Apply knowledge of logistic regression in classification problems.	Apply
CO 4	Apply the method of regularization in linear and logistic regression problems.	Apply
CO 5	Discuss the applications of machine learning in telecommunication applications.	Understand

iii) SYLLABUS

Introduction to learning and machine learning: supervised/unsupervised/reinforcement learning. Linear Regression with One Variable: Model Representation, Cost Function, Gradient Descent

Linear Regression with Multiple Variables: Multiple Features, Gradient Descent for Multiple Variables, Features and Polynomial Regression

Logistic Regression: Classification, Hypothesis Representation, Decision Boundary, Simplified Cost Function and Gradient Descent

Regularization: The Problem of Overfitting, Cost Function, Regularized Linear Regression, Regularized Logistic Regression, Machine learning for wireless communication.

iv) REFERENCES:

1. Christopher Bishop, *Pattern Recognition and Machine Learning*, First Edition, Springer, 2016.
2. K. P. Soman, R. Loganathan, and V. Ajay, *Machine Learning with SVM and Kernel Methods*, First Edition, PHI Learning Private Ltd., New Delhi, 2011.
3. https://www.comsoc.org/publications/best-readings/machine-learning-communications

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to learning and machine learning: supervised/unsupervised/reinforcement learning. Linear Regression with One Variable: Model Representation, Cost Function, Gradient Descent	**8**
II	Linear Regression with Multiple Variables: Multiple Features, Gradient Descent for Multiple Variables, Features and Polynomial Regression	**7**
III	Logistic Regression: Classification, Hypothesis Representation, Decision Boundary, Simplified Cost Function and Gradient Descent	**7**
IV	Regularization: The Problem of Overfitting, Cost Function, Regularized Linear Regression, Regularized Logistic Regression	**8**
V	Machine learning for physical layer design in wireless communication: Adaptive modulation and coding (AMC) – using Support vector machines, k-nearest neighbours.	**8**
VI	Machine learning for mobile network design: User grouping/clustering in D2D, HetNets for offloading	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P79A	Seminar II	PWS	0	0	2	2	2020

i) COURSE OBJECTIVES:

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills

ii) APPROACH:

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study

iii) EXPECTED OUTCOMES

Upon successful completion of the Seminar, the student should be able to:

Course Outcomes	Description	Level
CO 1	Identify promising new directions of various cutting edge technologies.	Apply
CO 2	Organize information after the study of research papers related to the branch of study.	Apply
CO 3	Develop effective written and oral communication	Apply

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P79B	PROJECT (PHASE 1)	PWS	0	0	12	6	2020

i) COURSE OBJECTIVES:

To make students

1) Do an original and independent study on the area of specialization.
2) Explore in depth a subject of his/her own choice.
3) Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4) Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5) Plan the experimental platform, if any, required for project work.

ii) APPROACH:

1) There will be three interim progress review of the Project (Phase I). The first review shall focus on the topic, and objectives. This review will be conducted within one month of the commencement of third semester classes.
2) The second review shall focus on the methodology. This review will be conducted within two months of the commencement of third semester classes.
3) The third review shall focus on the design and expected results, and scope of the work which has to be accomplished in the fourth semester. This review will be conducted towards the close of the third semester.

iii) EXPECTED OUTCOMES

Upon successful completion of the Project (Phase I), the student should be able to:

Course Outcomes	Description	Level
CO 1	Identify a topic of interest in the field of Telecommunication Engineering.	Apply
CO 2	Interpret and summarize several available literature in the preferred field of study.	Analyze
CO 3	Develop comprehensive solution to issues identified.	Analyze
CO 4	Develop effective written and oral communication.	Apply

SEMESTER – IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1P79C	PROJECT (PHASE 2)	PWS	0	0	24	12	2020

i) COURSE OBJECTIVES:

To continue and complete the project work identified in Project (Phase I).

ii) APPROACH:

1) There will be three interim progress review of the Project (Phase II). The first review shall focus on the progress of the implementation of the design made in Project (Phase I). This review will be conducted within one month of the commencement of third semester classes.

2) The second review shall focus on the quality and quantum of the work completed.

   This review will be conducted within two months of the commencement of third semester classes.

3) The third review shall focus on the completed implementation and the results. This review will be conducted towards the close of the third semester.

4) At least one technical paper has to be prepared and published in journals / conferences based on their project work.

iii) EXPECTED OUTCOMES

Upon successful completion of the Project (Phase II), the student should be able to:

Course Outcomes	Description	Level
CO 1	Use the equipment or software to investigate experimentally/ numerically the project work.	Apply
CO 2	Analyze data to solve the problem identified.	Analyze
CO 3	Interpret the results of the detailed studies conducted to arrive at valid conclusions.	Evaluate
CO 4	Develop effective written and oral communication	Apply