GOVERNMENT COLLEGE OF ENGINEERING
SALEM - 636 011

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS 2018A

CURRICULAM AND SYLLABI

M.E. COMMUNICATION SYSTEMS

M.E. Communication Systems – Full Time

Course code	Name of the Course	Category	Contact periods	Lecture	Tutorial/ Demo*	Practical	Credit	CA	FE	Total
			Hours/Week					Maximum Marks		
SEMESTER I										
18COC11	Statistical Information Processing	Core	3	3	0	0	3	40	60	100
18COC12	Advanced Digital Communication Techniques	Core	3	3	0	0	3	40	60	100
18COE1X	**Elective I**	Elect 1	3	3	0	0	3	40	60	100
18COE2X	**Elective – II**	Elect 2	3	3	0	0	3	40	60	100
18COC13	Statistical Information Processing Lab		4	0	0	4	2	40	60	100
18COC14	Advanced Digital Communication System Lab	Core	4	0	0	4	2	40	60	100
18MLC01	Research Methodology and IPR	MLC	3	3	0	0	3	40	60	100
18AC1X	Audit course 1	Audit	2	0	0	0	0	100	0	100
	TOTAL						19			**800**
SEMESTER II										
18COC21	Antennas and Radiating Systems	Core	3	3	0	0	3	40	60	100
18COC22	Advanced Digital Signal Processing	Core	3	3	0	0	3	40	60	100
18COE3X	Elective-III	Elect 3	3	3	0	0	3	40	60	100
18COE4X	Elective-IV	Elect 4	3	3	0	0	3	40	60	100
18COC23	Antennas and Radiating Systems lab	Core	4	0	0	4	2	40	60	100
18COC24	Advanced Digital Signal Processing Lab	Core	4	0	0	4	2	40	60	100
18CO205	Mini Project		4	0	0	4	2	40	60	100
18AC2X	Audit course 2	Audit	2	0	0	0	0	100	0	100
	TOTAL						18			**800**
SEMESTER III										
18COE5X	Elective – V	Elect 5	3	3	0	0	3	40	60	100
18COE6X	Elective - VI	Elect 6	3	3	0	0	3	40	60	100
18CO301	Dissertation Phase – I		20	0	0	20	10	80	120	200
	TOTAL						16			**400**
SEMESTER IV										
18CO401	Dissertation Phase – II		32	0	0	32	16	160	240	400
	TOTAL						16			**400**

Total Credits for the programme = 19 +18+16+16=69

List of Programme Electives:
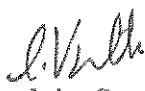
Course Code	Name of Course
Elective 1	
18COE11	Multimedia Compression Techniques
18COE12	Advanced Communication Networks
18COE13	Wireless Sensor Networks
Elective II	
18COE21	RF and Microwave Circuit Design
18COE22	Optical Networks
18COE23	Satellite Communication
Elective III	
18COE31	Wireless and Mobile Communication
18COE32	Pattern Recognition and Machine learning
18COE33	Voice and data networks
Elective – IV	
18COE41	Spread Spectrum Communication
18COE42	MIMO System
18COE43	High Performance Networks
Elective –V	
18COE51	Cognitive Radio
18COE52	Internet of Things
18COE53	VLSI for Wireless Communication
Elective –VI	
18COE61	Remote Sensing
18COE62	Wavelet signal processing
18COE63	Bio Mems
18COE64	Big Data Technology

List of Audit Courses:

Course Code	Name of Course
Audit-I	
18AC01	English for Research Paper Writing
18AC02	Disaster Management
Audit-II	
18AC05	Constitution of India
18AC06	Pedagogy Studies
18AC08	Personality Development through Life Enlightenment Skills.

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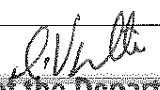Government College of Engineering
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18COC11	STATISTICAL INFORMATION PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To introduce various decision making system, Filtering techniques and Statistical operations.
2.	To impart knowledge on Estimation Theory.
3.	To gain knowledge on Information Theory.

		9	+	0
Unit I	**RANDOM SIGNAL MODELLING AND DECISION THEORY**			

Linear System with random input – Forward and Backward Predictions – Levinson Durbin Algorithm. Hypothesis Testing: Bayesian Hypothesis Testing – Minimax Hypothesis Testing – Neyman-Pearson Hypothesis Testing – Composite Hypothesis Testing.

		9	+	0
Unit II	**ESTIMATION THEORY**			

Maximum Likelihood Estimation – Generalized Likelihood Ratio Test – Criteria for Good Estimators – Bayes' Estimation Minimum Mean – Square Error Estimate – Minimum Mean Absolute Value of Error Estimate – Maximum A Posteriori Estimate – Multiple Parameter Estimation Best Linear Unbiased Estimator – Least-Square Estimation Recursive Least-Square Estimator.

		9	+	0
Unit III	**SPECTRAL ANALYSIS**			

Estimated autocorrelation function – Periodogram – Averaging the periodogram (Bartlett Method) – Welch modification – Parametric method – AR(p) spectral estimation and detection of Harmonic signals.

		9	+	0
Unit IV	**INFORMATION THEORY AND SOURCE CODING**			

Introduction – Uncertainty - Information and Entropy- Source coding theorem- Huffman- Shanon Fano - Arithmetic- Adaptive coding - RLE - LZW Data compaction- - LZ-77- LZ-78. Discrete Memory less channels- Mutual information - Channel capacity- Channel coding theorem- Differential entropy and mutual information for continuous ensembles.

		9	+	0
Unit V	**APPLICATION OF INFORMATION THEORY**			

Group- Ring and Field- Vector- GF addition- multiplication rules. Introduction to BCH codes - Primitive elements- Minimal polynomials - Generator polynomials in terms of Minimal polynomials- Examples of BCH codes and Decoding - Reed- Solomon coding and Decoding.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Characterize and apply probabilistic techniques in modern decision systems.
CO2	:	Demonstrate and compare various Estimation techniques
CO3	:	Understand and analyse Spectral content in Random Signals.
CO4	:	Apply various source coding techniques to real time data

Text Books:

1.	D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.
2.	Rodger E. Ziemer, Roger L. Peterson, "Introduction to Digital Communication", Prentice Hall, 2001.

Reference Books:

1.	H.Vincent Poor, "An Introduction to Signal Detection and Estimation", Springer Second Edition, 1994.
2.	F. J. MacWilliams and N. J. A. Sloane, "The Theory of Error-Correcting Codes", New York, North-Holland, 1977.
3.	R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.
4.	Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes",4th Edition, McGraw-Hill, 2002.

E – Reference

1.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-432-stochastic-processes-detection-and-estimation-spring-2004/
2.	https://nptel.ac.in/courses/117103018/
3.	https://www.coursera.org/learn/information-theory

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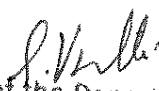Government College of Engineering
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18COC12	ADVANCED DIGITAL COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To make the students understand the different modules in the digital communication system with mathematical interpretation of signals and the channels.
2	To analyse the receiver filters in the presence of noise and the baseband shaping techniques.
3	To impart the knowledge of the pass band modulation techniques and to enhance the technical knowledge in designing error free digital communication systems.

Unit I	INTRODUCTION TO DIGITAL COMMUNICATION	9	+	0

Digital communication system (description of different modules of the block diagram) - Geometric Interpretation of signals: Gram-Schmidt Orthogonalization procedure - Mathematical models of Communication Channels: Additive Noise channel – Linear Filter Channel - Linear Time - Variant Filter Channels - Band pass signals and systems: Hilbert Transform - Pre Envelope - Complex envelope.

Unit II	BASEBAND RECEPTION TECHNIQUES	9	+	0

Detection: Detection of known signals in Noise - Detection of signals with unknown phase in noise - Probability of error - Receiver: Correlation receiver - Matched filter receiver - Estimation: Concepts and criteria - Maximum Likelihood Estimation - Wiener Filter for waveform Estimation - Linear Prediction - Linear Predictive vocoders - Adaptive Filters.

Unit III	BASBAND SHAPING AND EQUALIZATION TECHNIQUES	9	+	0

Baseband Shaping for data Transmission: Inter Symbol Interference - Nyquist Criterion - Controlled ISI - Eye pattern - Equalization: Fundamentals of Equalization - Survey of equalization techniques - Linear equalizers - Non-Linear equalization - Adaptive equalization for data transmission - Algorithms for Adaptive equalization.

Unit IV	PASSBAND TRANSMISSION OF DIGITAL SIGNALS AND MULTIPLE ACCESS TECHNIQUES	9	+	0

Digital Modulation Formats - Pass band Transmission model - Coherent Binary Modulation Techniques: Generation – Detection - Signal space diagram - Bit error probability - Power spectra and waveforms of BPSK, BFSK, QPSK and MSK schemes – Differential phase shift keying – Comparison of Digital modulation systems using a single carrier – Introduction to M-ary Modulation techniques - FDMA – TDMA – CDMA - SDMA

Unit V	BLOCK AND CONVOLUTIONAL CODED DIGITAL COMMUNICATION	9	+	0

Block codes: Properties-Examples of Block codes-case study: Reed-Solomon codes - cyclic codes -Convolutional codes: Representation of codes using Matrix – Polynomial - State diagram - Tree diagram and Trellis diagram – Properties – Decoding techniques of convolutional codes: Maximum likelihood detection - Viterbi algorithm methods – Turbo coding - Applications: Coding for WGN channels - Coding for compound error channels - Block codes for error control in data storage - Coding for efficient utilization of bandwidth and power.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Apply the knowledge of mathematical models of channels in the design of Digital Communication systems.
CO2	:	Classify the different receiver used in the digital communication systems.
CO3	:	Analyse the eye patterns and can select the algorithm for equalizer to reduce ISI.
CO4	:	Design a digital modulators and can generate codes for error free communication.

Text Books:

1.	Simon Haykin, 'Digital Communication Systems ' , John Wiley & sons, 2014
2.	Theodore S.Rappaport "Wireless Communications: Principles and Practice', 2nd Edition, Pearson, 2012.

Reference Books:

1.	J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Pearson Education, 2005.
2.	S. Haykins, 'Communication Systems', 5th Edition., John wiley, 2014.
3.	M. K. Simon, S. M. Hinedi and W. C. Lindsey, 'Digital Communication Techniques: Signaling and detection' Prentice Hall India, N. Delhi, 1997.
4.	Wayne Tomasi, 'Advanced Electronic Communication Systems, 6th Edition., Pearson Education, 2014.

E-References:

1.	https://en.wikipedia.org/wiki/Gram–Schmidt_process
2.	https://books.google.co.in/books?isbn=0070591172
3.	https://nptel.ac.in › courses

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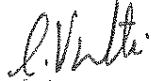Electronics and Communication Engineering
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18MLC01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To develop the subject of their research, encourage the formation of a higher level of trained intellectual ability.
2.	To develop critical analysis, rigor, and independence of thought, foster individual judgment, and skill in the application of research theory and methods.
3	To understand skills required in writing research proposals, reports and dissertation.

UNIT I	INTRODUCTION TO RESEARCH	9	+	0

Meaning of research problem, Sources of the research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of the research problem. Approaches to investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II	EFFECTIVE LITERATURE STUDIES APPROACHES, ANALYSIS	9	+	0

Developing the theoretical framework of the research - Developing operational statements of the problem - Criteria for evaluating research approach - Hypotheses: Parametric and non-parametric testing- Establishing the reliability and validity of findings with literature review and experiments – documentation, Plagiarism, Research ethics.

UNIT III	EFFECTIVE TECHNICAL WRITING, HOW TO WRITE REPORT, PAPER	9	+	0

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

UNIT IV	NATURE OF INTELLECTUAL PROPERTY	9	+	0

Patents, Designs, Trade and Copyright. The process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V	PATENT RIGHTS AND IPR	9	+	0

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total = 45 Periods

COURSE OUTCOMES:

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

CO1	:	Understand research problem formulation.
CO2	:	Analyze research-related information
CO3	:	Understand that today"s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO4	:	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to the creation of new and better products, and in turn brings about, economic growth and social benefits.

TEXT BOOKS:

1.	Stuart Melville and Wayne Goddard, ―Research methodology: an introduction for science & engineering students‖
2.	Wayne Goddard and Stuart Melville, ―Research Methodology: An Introduction‖

REFERENCE BOOKS:

1.	Mayall, ―Industrial Design‖, McGraw Hill, 1992.
2.	Niebel, ―Product Design‖, McGraw Hill, 1974.
3.	Asimov, ―Introduction to Design‖, Prentice Hall, 1962.
4.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, ―Intellectual Property in New Technological Age‖, 2016.

E - Reference

1.	https://www.udemy.com/topic/research-methods/
2.	https://www.ficciipcourse.in/

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18COC13	STATISTICAL INFORMATION PROCESSING LABORATORY	S	T	P	C
		0	0	4	2

Course Objectives:

1.	To impart knowledge on spectrum estimator.
2	To gain knowledge on various adaptive filters and signal estimators.
3	To implement various Source Coding Techniques.

EXPERIMENTS : (Implementation/Simulation)

1.	Nonparametric and methods of power spectrum estimator (Bartlett's and Welch's methods).
2.	AR method of power spectrum estimation.
3.	Noise cancellation using Winner filter and adaptive filter.
4.	Maximum Likelihood Estimator.
5.	Least Square Estimator.
6.	Recursive Least Square Estimator.
7.	Shanon Fano Coder.
8.	Adaptive Huffman Coder.
9.	BCH Coder and Decoder.
10.	Reed Solomon Coder and Decoder.

Total (P)= 45 Periods

Course Outcomes:

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

CO1	:	Design channel estimators.
CO2	:	Use various Noise Cancellation Algorithm.
CO3	:	Implement various systems involving functionalities in detection.
CO4	:	Design source coders according to the requirements.

Reference Books:

1.	H.Vincent Poor, "An Introduction to Signal Detection and Estimation", Springer Second Edition, 1994.
2.	D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

E-References:

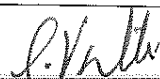| 1.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-432-stochastic-processes-detection-and-estimation-spring-2004/
2.	https://nptel.ac.in/courses/117103018/
3.	https://www.coursera.org/learn/information-theory

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18COC14	ADVANCED DIGITAL COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives:

1.	To supplement the theory course Advanced Digital Communication Techniques.
2.	To assist the students in obtaining a better understanding of the operation of different modules of digital communication systems.
3.	To provide experience in analyzing and testing of digital communication systems using simulation software as well as lab equipments.

EXPERIMENTS: Design and Implement / Simulation of,

1.	Computation of the analytical signal and the Power Spectral Density using Hilbert Transform.
2.	Analysis of the harmonic distortion of a system in the presence of noise.
3.	Matched filter.
4.	Weiner filter.
5.	Eye pattern of a communication system.
6.	Channel Equalizer .
7.	Linear and cyclic codes.
8.	An end-to-end communication link using turbo codes in and AWGN channel and the estimation of the Bit Error Rate.
9.	Performance evaluation of all the digital modulation schemes.
10.	Comparative study of SDR and HDR.
11.	Digitisation of analog signal using SDR.
12.	Base band and pass band digital modulation using SDR.

Total (P)= 60 Periods

Course Outcomes:

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

CO1	:	Compute and analyse the distortion in the presence of noise and to design filters.
CO2	:	Analyse the system using eye pattern and design equalizer to avoid ISI.
CO3	:	Design an error free system using coding techniques.
CO4	:	Select the modulation scheme and able to design system using SDR.

References:

1.	M. K. Simon, S. M. Hinedi and W. C. Lindsey, 'Digital Communication Techniques: Signaling and detection' Prentice Hall India, N. Delhi, 1995.
2.	W. Tomasi, Advanced Electronic Communication Systems, 4th Edition., Pearson Education, 1998.

E-References:

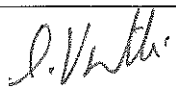| 1.	file:///F:/SDR/SDR%20lab.pdf
2.	file:///F:/SDR/3801-manuel.pdf
3.	https://nptel.ac.in › courses

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18COC21	ANTENNAS AND RADIATING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1	To know the different types of antennas and fundamental parameters.
2	To describe the various linear wire antennas, loop antennas, and arrays
3	To gain knowledge of aperture, Horn antennas, Micro stripe and reflector antennas

Unit I	TYPES OF ANTENNAS AND FUNDAMENTAL PARAMETERS OF ANTENNAS	9	+	0

Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector, effective length, Friis Transmission equation, Antenna Temperature.

Unit II	LINEAR WIRE ANTENNAS AND LOOP ANTENNAS	9	+	0

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Unit III	LINEAR ARRAYS	9	+	0

Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Binomial array, Chebyshev array, Super directivity, Planar array, Design consideration.

Unit IV	APERTURE AND HORN ANTENNAS	9	+	0

Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture .Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

Unit V	MICRO STRIP AND REFLECTOR ANTENNAS	9	+	0

Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch. Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Compute the far field distance, radiation pattern and gain of an antenna for given current Distribution.
CO2	:	Estimate the input impedance, efficiency and ease of match for antennas.
CO3	:	Compute the array factor for an array of identical antennas
CO4	:	Design antennas and antenna arrays for various desired radiation pattern characteristics.

Text Books:

1.	E.C. Jordan & K.G. Balmain, "Electromagnetic waves & Radiating Systems", Prentice Hall, India, Reprint 2010.
2.	John D.Kraus and RonalatoryMarhefka, "Antennas", Tata McGraw-Hill Book Company, 2010.

Reference Books:

1.	Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 2012.
2.	Elliot, R.S: "Antenna theory and design", PHI, New Delhi, 1985.
3.	R.C.Johnson and H.Jasik, "Antenna Engineering hand book", Mc-Graw Hill, 1984.
4.	Girish Kumar and K.P.Ray, "Broad band Micro-strip antennas", Artech house, 2003.

E-References:

1.	http://nptel.ac.in/courses/117105131/
2.	http://nptel.ac.in/courses/106105082/33

18COC22	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	1	0	3

COURSE OBJECTIVE

1.	The student comprehends mathematical description and modelling of discrete time random signals.
2.	The student is conversant with various estimation techniques.
3.	The student is familiar with prediction and filtering concepts and techniques.

Unit I	DISCRETE RANDOM SIGNAL PROCESSING	9	+	3

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

Unit II	SPECTRUM ESTIMATION	9	+	3

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

Unit III	LINEAR ESTIMATION AND PREDICTION	9	+	3

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

Unit IV	ADAPTIVE FILTERS	9	+	3

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

Unit V	MULTIRATE DIGITAL SIGNAL PROCESSING	9	+	3

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

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
CO2	:	State Parseval's theorem, W-K theorem, principle of orthogonality, spectral factorization theorem, Widrow -Hoff LMS algorithm and Shannon's sampling theorem, and define linear prediction, linear estimation, sample auto-correlation, periodogram, bias and consistency.
CO3	:	Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval's theorem, W-K theorem and normal equations.
CO4	:	Design AR, MA, ARMA models, Weiner filter, anti-aliasing and anti-imaging filters, and develop FIR adaptive filter and polyphase filter structures, Simulate spectral estimation algorithms and basic models on computing platform.

Text Books:

1.	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall India, New Delhi, 2005.
2.	Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006

Reference Books:

1.	P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.
2.	Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.
3.	Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
4.	S. Kay," Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ1988

EReferences:

1.	https://nptel.ac.in/courses/108106136/
2.	htts://www.coursera.org/learn/dsp
3.	https://nptel.ac.in/syllabus/117103019/

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18COC23	ANTENNAS AND RADIATING SYSTEMS LAB	L	T	P	C
		0	0	2	1

Course Objectives:

1.	Understand the radiation produced by antennas and arrays.
2.	Study the characteristics of patch antennas.
3.	Able to simulate various antennas and to study it's various parameters.

EXPERIMENTS

1.	Design and study the radiation pattern of Broad side and End Fire Array.
2.	Design and study the radiation pattern of Yagi Uda Antenna and Log Periodic Dipole Array.
3.	Measure the Radiation Pattern of Loop Antenna.
4.	Radiation Pattern Measurement of Dipole and monopole Antenna.
5.	Measure the Radiation pattern of Horn Antenna.
6.	Design of rectangular micro-stripe patch antenna.
7.	Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna. Simulation of quarter wave, full wave antenna and comparison of their parameters.
8.	Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9	Study the effect of change in distance between elements of array on radiation pattern of dipole array.
10	Simulation of monopole antenna with and without ground plane. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.

Total (P)= 45 Periods

Course Outcomes:

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

CO1	:	Design and study the radiation pattern of antennas and arrays
CO2	:	Understand to effect of phase and element spacing in array.
CO3	:	Use HFSS to simulate different types of antennas.
CO4	:	Understand the impact of variation in antenna parameters in radiation pattern.

Reference Books:

1.	Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 2012.
2.	Elliot, R.S: "Antenna theory and design", PHI, New Delhi, 1985.

E-References:

1.	https://www.academia.edu/3356546/High_Frequency_Structure_Simulator_HFSS_Tutorial
2.	http://www.antenna-theory.com/antennas/main.php

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18COC24	ADVANCED DIGITAL SIGNAL PROCESSING LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1.	To impart knowledge for implementing various DSP algorithm.
2	To gain knowledge on signal multirate processing.
3	To implement FIR and IIR filters.

EXPERIMENTS

1.	Determination of Power Spectrum of a given signal.
2.	Simulation of LP and HP FIR filter for a given sequence
3.	Implementation of LP and HP IIR filter for a given sequence.
4.	Generation of Sinusoidal signal through filtering.
5.	Generation of DTMF signals.
6.	Simulation of Decimation Process.
7.	Simulation of Interpolation Process.
8.	Simulation of I/D sampling rate converters.
9.	Simulation of Impulse Response of First Order and Second Order System
10.	Simulation of Pseudorandom noise sequence.
11.	Square, Ramp signal Generation Using a Lookup Table.

Total (P)= 45 Periods

Course Outcomes:

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

CO1	:	Develop and experiment coding from basic mathematical operations to complex operations in signal processing.
CO2	:	Visualize the amplitude and phase spectrum of the signal in frequency domain.
CO3	:	Simulate FIR and IIR filter using MATLAB.
CO4	:	Understand the properties of discrete time signals.

Reference Books:

1.	Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
2.	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall India, New Delhi, 2005.

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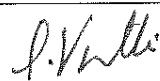| 1.	https://nptel.ac.in/courses/108106136/
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ELECTIVE LIST

18COE11	MULTIMEDIA COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To study the basics of various data coding techniques.
2.	To gain knowledge on various audio compression techniques.
3.	To understand various image and video compression techniques.

Unit I	INTRODUCTION		
		9	+	0

Compression Techniques – Overview of information theory - Lossless and Lossy coding– Modeling and Coding - Taxonomy of compression techniques – Rate distortion theory - Huffman coding – Non-Binary Huffman codes – Adaptive Huffman coding – Applications of Huffman coding.

Unit II	ARITHMETIC CODING AND DICTIONARY TECHNIQUES		
		9	+	0

Introduction - Coding a sequence – Generating deciphering the tag – Generating a binary code – Uniqueness of arithmetic code – Algorithm, Integer implementation – Comparison of Huffman and Arithmetic coding – Applications -Static and Adaptive dictionary – LZ77, LZ78, LZW approach – Applications - Facsimile encoding – Run length coding – Comparison of MH, MR, MMR and JBIG - Scalar and Vector Quantization.

Unit III	AUDIO COMPRESSION		
		9	+	0

Audio compression techniques - Frequency domain and filtering - Basic sub-band coding -Application to speech coding - G.722 - Application to audio coding - MPEG audio - Silence suppression - Speech compression techniques – Vocoders.

Unit IV	IMAGE COMPRESSION		
		9	+	0

Predictive techniques - DPCM, DM - KL transform – Discrete cosine, Walsh, Hadamard transform - JPEG, Wavelet based compression: Quad-trees, EZW, SPIHT, JPEG-2000.

Unit V	VIDEO COMPRESSION		
		9	+	0

Video signal representation – Motion compensation – MPEG standards - Motion estimation techniques - H.261 family of standards - Motion video compression.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Code information using various Lossy and Lossless methods.
CO2	:	Apply the concepts dictionary based coding techniques.
CO3	:	Do various analysis on audio compression.
CO4	:	Implement image and video compression

Text Books:

1.	Khalid Sayood, "Introduction to Data Compression", Morgan Kaufman, 2017.
2.	Salomon D, "Data Compression The Complete Reference", Springer, 2015.

Reference Books:

1.	Jan Vozer, "Video Compression for Multimedia", AP Press, New York, 1995.
2.	Alistar Moffat, "Compression and Coding Algorithms", Kluwer Academic Publishers, 2002
3.	Salomon D, "A Guide to Data Compression Methods", Springer, 2002.

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1.	https://www.coursera.org
2.	https://onlinecourses.nptel.ac.in

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18COE12	ADVANCED COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To introduce various protocols and standards in networking
2.	To understand traffic engineering and capacity planning.
3.	To gain knowledge on network security and multimedia over internet.

Unit I	INTRODUCTION	9	+	0

Protocols and Standards, Organizations, Internet standards, TCP/IP protocol suits TCP/IP IP: Datagrams, Fragmentation, Options, Checksum, IP package, TCP: TCP services, TCP features, Segment, TCP connection, Windows in TCP, Flow control, Error control, Congestion control, TCP timer, Delay Tolerant networks

Unit II	ADVANCED COMMUNICATION NETWORKS AND SERVICES	9	+	0

Frame relay, ATM, X.25, ARPANET, FDDI, ISDN, B-ISDN, Bluetooth and RFID. Optical networking: SONET/SDH, Dense Wavelength Division Multiplexing.

Unit III	TRAFFIC ENGINEERING AND CAPACITY PLANNING	9	+	0

Data traffic, Congestion and Congestion control, Quality of Services and techniques to improve QoS, QoS in Switched networks

Unit IV	NETWORK SECURITY	9	+	0

Cryptography, Symmetric-Key Algorithms, Public-Key Algorithms, Digital Signatures, Management of Public Keys, IPsec, Firewalls, Virtual Private Networks, Wireless Security, Security Issues And Challenges in Wireless Networks, Authentication Protocols, Email Security, Web Security, Social Issues

Unit V	MULTIMEDIA OVER INTERNET	9	+	0

RTP, RSVP, IP multicasting, Voice Digitization standards, VoIP and its protocol

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the concept behind TCP/IP and other networking protocols
CO2	:	Implement problem based on traffic engineering and capacity planning
CO3	:	Solve various information security algorithms from various scenarios.
CO4	:	Apply the various concept learnt in multimedia over internet.

Text Books:

1.	Jeffrey S Beasley, Plyasat Nilkaew " Practical Guide to Advanced Networking" Third edition, 2013, Pearson
2.	Behrouz A Forouzan " Data Communication and Networking" , fourth edition, SIE, Tata McGraw Hill, , 2017
3.	Nina Godbole "Information Systems Security: Security Management, Metrics, Frameworks and Best Practices", second edition, Wiley , 2017

Reference Books:

1.	Doug Loe " Networking All in one for Dummies" Sixth edition, Wiley, , 2016
2.	Kurose James F" Computer Networking: A Top Down Approach" Sixth edition, Pearson, 2017
3.	Tanenbaum " Computer Networks" Fifth edition, Pearson, 2013

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| 2. | http://nptel.ac.in/courses/106105081/1 |

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18COE13	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To obtain a broad understanding of the technologies and applications of wireless sensor networks
2.	To gain knowledge on the protocols used for wireless sensor networks
3.	To understand the tools used for wireless sensor networks

Unit I	WSN ARCHITECTURE		
		9 +	0

Challenges for Wireless Sensor Networks – Difference between mobile ad-hoc and sensor networks – Applications of sensor networks – Single-node architecture –Hardware components – Energy consumption of sensor nodes – Operating Systems and execution environments – Network architecture – Sensor network scenarios – Optimization goals and figures of merit – Gateway concepts.

Unit II	COMMUNICATION PROTOCOLS		
		9 +	0

Physical layer and transceiver design considerations – MAC protocols for wireless sensor networks – Low duty cycle protocols and wakeup concepts – Address and name management – Assignment of MAC addresses – Routing protocols – Energy-efficient routing – Geographic routing.

Unit III	INFRASTRUCTURE ESTABLISHMENT		
		9 +	0

Time synchronization – Introduction to the time synchronization problem – Protocols based on sender / receiver synchronization – Protocols based on receiver/ receiver synchronization – Localization and positioning – Properties – Possible approaches – Mathematical basis for the iteration problem – Single-hop localization – Positioning in multi-hop environments.

Unit IV	TOPOLOGY CONTROL		
		9 +	0

Motivation and basic ideas – Controlling topology in flat networks – Hierarchical networks by dominating sets – Hierarchical networks by clustering – Combining hierarchical topologies and power control – Adaptive node activity – Data aggregation – Data centric storage.

Unit V	SENSOR NETWORK PLATFORMS AND TOOLS		
		9 +	0

Sensor node hardware – Berkeley motes – Programming challenges – Node-level software platforms – Node-level simulators – State-centric programming.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Gain knowledge on some existing applications of wireless sensor networks.
CO2	:	Get exposure to network protocol design and apply these principles in the context of wireless sensor networks.
CO3	:	Learn various hardware, software platforms that exist for sensor networks.
CO4	:	Gain knowledge on various topologies available in wireless sensor networks

Text Books:

1.	Holger Karl, Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.
2.	Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2014.

Reference Books:

1.	Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks-Technology, Protocols, And Applications", John Wiley, 2007.
2.	Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", John Wiley and Sons Publications, 2010.
3.	Bhaskar Krishnamachari, "Networking Wireless Sensors", Cambridge Press, 2009.
4.	Mohammad Ilyas, Imad Mahgoub, "Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems", CRC Press, 2004.

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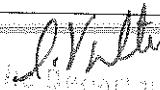| 1.	http://nptel.ac.in/courses/106105160/
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18COE21	RF AND MICROWAVE CIRCUIT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To enable the student to understand the various components that constitute RF and Microwave system
2.	To enable the student to understand the working concepts of RF active components and amplifiers
3	To expose the student to know the basic analysis techniques needed for evaluating the performance of an RF system for various applications

Unit I	INTRODUCTION	9	+	0

Importance of RF and Microwave Concepts and Applications- and Units Frequency Spectrum, , Dimensions - RF Behaviour of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, Types of Transmission Lines-Equivalent Circuit representation.

Unit II	RF DEVICE AND CIRCUIT	9	+	0

RF amplifier design- power gain equations - maximum gain design, low noise amplifier design, high power amplifier design- stability considerations; RF oscillator design -one – port and two – port negative resistance oscillators - oscillator design using large – signal measurements; RF Mixer Design: Single ended mixer – double ended mixer.

Unit III	RF PASSIVE COMPONENTS AND TRANSMISSION LINE ANALYSIS	9	+	0

High Frequency Components: Resistors- capacitors and inductors ; Transmission line analysis - line equation - microstrip line - SWR - Voltage reflection co– efficient - propagation constant - phase constant - phase velocity - Smith chart - parallel RL and RC circuits.

Unit IV	RF FEEDBACK SYSTEMS AND POWER AMPLIFIERS	9	+	0

Stability of feedback systems: Gain and phase margin- root– locus techniques -time and frequency domain considerations - compensation ; General model – Class A, AB, B, C, D, E and F amplifiers - power amplifier linearization techniques - efficiency boosting techniques - ACPR metric- design considerations.

Unit V	PLL AND FREQUENCY SYNTHESIZERS	9	+	0

PLL: Linearised Model – Noise properties – Phase detectors – Loop filters and Charge pumps Frequency Synthesizers: Integer-N frequency synthesizers – Direct Digital Frequency synthesizers.

Total (L+T)= 45 Periods

Course Outcomes:

After the successful completion of the course, the students will be able to

CO1	:	Understand the behaviour of passive components at very high frequency.
CO2	:	Design High Frequency Mixer and Amplifiers.
CO3	:	Do stability analysis for power amplifiers.
CO4	:	Understand about frequency synthesizers and linearised PLL model.

Text Books:

1.	Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition,
2.	Reinhold Ludwig and Powel Bretchko," RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.

Reference Books:

1.	Devendra K. Misra, "Radio Frequency and Microwave Communication Circuits – Analysis and Design", Wiley Student Edition, John Wiley & Sons, 2nd edition, July 2004.
2.	Christopher Bowick, Cheryl Aljuni and John Biyler, "RF Circuit Design", Elsevier Science, 2008.
3.	Joseph Carr, "Secrets of RF Design", Tata McGraw Hill Publications, 3 rd Edition, 2004.
4.	B.Razavi, "RF Microelectronics", Pearson Education, 1997.

E-References:

1.	http://www.qsl.net/va3iul/Files/RF_courses_lectures.htm
2.	http://www.seas.ucla.edu/brweb/teaching.html
3.	http://nptel.ac.in/courses

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18COE22	OPTICAL NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To understand Optical system components like optical amplifiers, wavelength converters..
2.	To gain the knowledge about the Network management and access networks.
3.	To learn the students to acquire a solid understanding of foundations of optical networks technologies, systems, networks issues.

Unit I	INTRODUCTION TO OPTICAL NETWORKS	9	+	0

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

Unit II	TRANSMISSION SYSTEM ENGINEERING	9	+	0

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

Unit III	OPTICAL NETWORK ARCHITECTURES	9	+	0

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

Unit IV	WDM NETWORK ELEMENTS	9	+	0

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

Unit V	NETWORK TOPOLOGIES AND PROTECTION SCHEMES	9	+	0

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

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	To enable the student to understand the importance of the backbone infrastructure for our present and future communication needs and familiarize them with the architectures and the protocol stack in use.
CO2	:	To understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods.
CO3	:	To expose the student to the advances in packet switching in the optical domain, the associated challenges and the possible solution approaches.
CO4	:	To introduce students the important areas of communication networks, mainly optical networks and photonic switching.

Text Books:

1.	Rajiv Ramaswami, Sivarajan, Sasaki, "Optical Networks: A Practical Perspective", MK, Elsevier, 3 rd edition, 2010.
2.	C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001

Reference Books:

1.	.Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multiwavelength Optical Networks – Architecture, Design and control ", Cambridge University Press, 2nd Edition, 2009.
2.	P.E. Green, Jr., "Fiber Optic Networks", Prentice Hall, NJ, 1993.
3.	Biswanath Mukherjee, "Optical WDM Networks", Springer, 2006.
4.	Vivek Alwayn, "Optical Network Design and Implementation", Pearson Education,2004

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1.	https://nptel.ac.in/downloads/117101054/
2.	http://ece.eng.wayne.edu/~avrutsky/Teaching/ECE5870/NotesFall10.html

18COE23	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To know the different orbits based on various laws of Kepler and calculation of elevation and azimuth angle based on geostationary orbits.
2.	To describe the various subsystems and outline the fundamental concepts of control mechanism
3.	To calculate the power requirement in satellite communication for uplink and down link.

Unit I	ORBITS AND LAUNCHING METHODS	9	+	0

Introduction – Frequency Allocations for Satellite Services – INTELSAT – U.S.Domsats – Polar Orbiting Satellites. Kepler's Laws – Definitions of Terms for Earth-orbiting Satellites – Orbital Elements – Apogee and Perigee Heights – Orbital Perturbations-Inclined orbits- Local Mean Solar Time and Sun-Synchronous Orbits. Geostationary Orbits: Introduction – Antenna Look Angels – The Polar Mount Antenna – Limits of Visibility – Near Geostationary Orbits – Earth Eclipse of Satellite – Sun Transit Outage – Launching Orbits.

Unit II	SPACE AND EARTH SEGMENT	9	+	0

Space Segment: Introduction - Power Supply – Attitude Control – Station Keeping – Thermal Control – TT&C Subsystem – Transponders - Antenna Subsystem – Morelos and Satmex5–- Anik-Satellites – Advanced Tiros-N Spacecraft. Earth Segment: Introduction – Receive-Only Home TV Systems– Master Antenna TV System – Community Antenna TV System – Transmit-Receive Earth Stations.

Unit III	SPACE LINK	9	+	0

Equivalent Isotropic Radiated Power – Transmission Losses – Link Power Budget Equation – System Noise - Carrier-to-Noise Ratio –The Uplink –Down link-Effects of rain – Combined Uplink and Downlink C/N Ratio – Inter modulation Noise- Inter-Satellite Links – Problems.

Unit IV	SATELLITE ACCESS	9	+	0

Introduction-Single Access – Preassigned FDMA, Demand-Assigned FDMA, SPADE System. Bandwidth-limited and Power-limited TWT amplifier operation-TDMA -On-board signal Processing for TDMA / FDMA operation, Satellite switched TDMA-Code Division Multiple Access.

Unit V	SATELLITE IN NETWORKS, MOBILE AND SPECIALIZED SERVICES	9	+	0

Satellite in networks: Introduction – Bandwidth – Network Basics –ATM – ATM over Satellite – Internet Layers – TCP link – Satellite Links and TCP – Direct Broadcast Satellite (DBS) Television: Orbital Spacing-Power Rating and Number of Transponders-Frequencies and Polarization-Transponder capacity-Bit rates for digital Television-The Home Receiver Outdoor Unit(ODU)-The Home Receiver Indoor Unit(IDU)-HDTV- Satellite Mobile Services-VSATs- Radarsat – GPS – Orbcomm - Iridium.

	Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the orbital laws and elements of satellite communication.
CO2	:	Understand the concept of geostationary orbit and the station keeping.
CO3	:	Know the concept of different space and earth segments and noise interference.
CO4	:	Know the available satellite access methods, Networks and specialized services.

Text Books:

1.	Dennis Roddy, Satellite Communications, Tata McGraw-Hill Education Private Limited, fourth edition, 2009
2.	Barry George Evans, Satellite communication systems, 3rd Edition, IET Publications 1999

Reference Books:

1.	Timothy Pratt – Charles Bostian& Jeremy Allmuti, Satellite Communications, John Willy & Sons (Asia) Pvt. Ltd. 2004
2.	Wilbur L. Pritchars Henri G.SuyderHond Robert A.Nelson, Satellite Communication Systems Engineering, Pearson Education Ltd., Second edition 2003..
3.	M.Richharia, Satellite Communication Systems (Design Principles Macmillan Press Ltd. Second Edition 2003.
4.	Satellite communication engineering By Michael O. Kolawole, CRC Press, 2002.

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18COE31	WIRELESS AND MOBILE COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To make the students understand the basics of wireless and mobile communication.
2	To learn various fundamental mobile radio propagation.
3	To analyse the issues pertaining to major obstacles in establishment and efficient management of Cellular systems and standards.

Unit I	INTRODUCTION AND MODERN WIRELESS COMMUNICATION STANDARDS	9	+	0

Introduction to wireless communications - History and evolution - Current wireless communication systems - requirements of wireless services - Technical challenges of wireless communications - Comparison of common wireless communication systems - Modern wireless communication systems: 2G Cellular networks - 3G wireless networks - 4G mobile web access - 5G faster wireless network - Wireless network standards.

Unit II	MOBILE RADIO PROPAGATION:LARGE SCALE PATH LOSS	9	+	0

Radio wave propagation mechanisms in the mobile environment – Propagation models: Free-space propagation model- Ground reflection model - Knife-edge diffraction model - Practical Link budget design using path loss models - Outdoor propagation models - Indoor propagation models .

Unit III	MOBILE RADIO PROPAGATION:SMALL-SCALE FADING AND MULTIPATH FADING	9	+	0

Small-Scale fading: Small scale multipath propagation - Impulse response model of a multipath channel - Small-scale multipath measurements - Parameters of mobile multipath channels – Types of small-scale fading-Rayleigh and Ricean distribution - Multipath fading: Clarke's model for flat fading - Two ray Rayleigh fading model - Introduction to shape factors: Angular spread - Angular constriction - Azimuthal Direction of maximum fading - Applying shape factors to wideband channels.

Unit IV	THE CELLULAR CONCEPT:SYSTEM DESIGN FUNDAMENTALS AND MODULATION SCHEMES	9	+	0

Frequency reuse - Channel Assignment strategies - Handoff starategies - Interference and system capacity - Trunking and grade of service - Improving coverage and capacity in cellular systems - Modulation: Constant envelope modulation - Spread Spectrum Modulation Technique - Modulation performance in Slow Flat – Fading Channel.

Unit V	EQUALISATION,DIVERSITY AND CHANNEL CODING	9	+	0

Equalisation:Fundamentals - Survey of equalization - Linear equalizers - Nonlinear equalization - Algorithms for adaptive equalization - Diversity: Practical Space Diversity Considerations - Polarizationnn diversity - Frequency diversity -Time diversity - RAKE receiver - Coding: RS-coding - Case study - Speech coding – Vocoders - LPC-Choosing Speech Codecs for Mobile communication - GSM codec - USDC codec.

	Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the difference in wireless compared to wired counterpart.
CO2	:	Understand the different propagation mechanisms and calculate large scale path loss.
CO3	:	Analyze small scale and multipath fading in mobile environment.
CO4	:	Analyze the cell structure and calculate interference and improve the coverage and capacity of cellular system.

Text Books:

1	Theodore S.Rappaport , "Wireless Communications:Principles and Practice", 2nd Edition.", Pearson,2012.
2	Simon Haykin, "Digital Communications" Student Edition, John Wiley & sons, 2008.

Reference Books:

1	A.Molisch,Wiley, "Wireless Communications", 2nd Edition, 2010.
2	V.K. Garg, "Principles and Applications of GSM", Pearson Edition.
3	V.K. Garg, "IS-95 CDMA and CDMA 2000", Pearson Edition.
4	S. Haykins, "Communication Systems", 5th Edition, John wiley, 2008.

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2	https://www.oreilly.com/library/view/wireless-communications-principles/0130422320/
3	https://en.wikipedia.org/wiki/Adaptive_equalizer

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18COE32	PATTERN RECOGNITION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To understand the concepts of Pattern classification.
2.	To gain knowledge on feature extraction and selection techniques
3.	To get exposure on Expert systems and Machine learning.

Unit I	PATTERN CLASSIFIER	9	+	0

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum likelihood estimation – Bayesian parameter estimation – Perceptron algorithm – LMSE algorithm – Problems with Bayes approach – Pattern classification by distance functions – Minimum distance pattern classifier- Clustering for unsupervised learning and classification – Clustering concept – C-means algorithm – Hierarchical clustering procedures – Graph theoretic approach to pattern clustering – Validity of clustering solutions.

Unit II	STRUCTURAL PATTERN RECOGNITION	9	+	0

Elements of formal grammars – String generation as pattern description – Recognition of syntactic description – Parsing – Stochastic grammars and applications – Graph based structural representation.

Unit III	FEATURE EXTRACTION AND SELECTION	9	+	0

Entropy minimization – Karhunen – Loeve transformation – Feature selection through functions approximation – Binary feature selection

Unit IV	INTRODUCTION TO AI AND PRODUCTION SYSTEMS	9	+	0

Introduction to AI-Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.

Unit V	PLANNING AND EXPERT SYSTEMS	9	+	0

Basic plan generation systems - Strips -Advanced plan generation systems – K strips -Strategic explanations - Why, Why not and how explanations. Learning- Machine learning, adaptive Learning- Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Implement pattern classification methods and structural pattern recognition.
CO2	:	Implement feature extraction and selection.
CO3	:	Apply AI problem solving techniques for machine learning
CO4	:	Apply the concepts of various planning algorithm and expert systems.

Text Books:

1.	Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 2012.
2.	Tou and Gonzales, "Pattern Recognition Principles", Wesley Publication Company, London, 2014

Reference Books:

1.	Duda R.O., and Har P.E., "Pattern Classification and Scene Analysis", Wiley, New York, 2013.
2.	Morton Nadier and Eric Smith P., "Pattern Recognition Engineering", John Wiley & Sons, New York, 2012
3.	Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning series)", The MIT Press; Second edition, 2009.
4	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson Education / Prentice Hall of India, 2015.

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18COE33	VOICE AND DATA NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To gain the knowledge on computer networks and provides a good background for advanced studies in communication networks.
2.	The students will be able to design different networks based on different Internet protocols and also able to work for different OSI layers.
3.	To get expose an interconnecting networks.

Unit I	INTRODUCTION TO VOICE AND DATA NETWORKS	9	+	0

Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

Unit II	TRANSMISSION METHODS AND SWITCHING	9	+	0

Layered and Layer less Communication, Cross layer design of Networks, Voice Networks(wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit III	DATA LINK LAYER PROTOCOLS	9	+	0

Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis

Unit IV	DELAY MODELS IN DATA NETWORKS	9	+	0

Queuing Models of Networks , Traffic Models , Little's Theorem, Markov chains, M/M/1and other Markov systems, Multiple Access Protocols - Aloha System , Carrier Sensing , Examples of Local area networks,

Unit V	INTERCONNECTING NETWORKS	9	+	0

Inter-networking, Bridging, Global Internet , IP protocol and addressing , Sub netting ,Classless Inter domain Routing (CIDR) , IP address lookup , Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control , Additive Increase/Multiplicative Decrease , Slow Start, Fast Retransmit/ Fast Recovery,

	Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	To be able to introduction to voice and data networks.
CO2	:	To Analyse the transmission methods and switching.
CO3	:	To understand the concept of data link layer protocols.
CO4	:	To Know the concept of interconnecting networks.

Text Books:

1.	D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, Prentice Hall, 1992.
2.	. L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach",5th Edition, Morgan Kaufman, 2011

Reference Books:

1.	Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1st Edition, Morgan Kaufman, 2004.
2.	Walrand, "Communications Network: A First Course", 2nd Edition, McGraw Hill, 2002. Leonard Kleinrock, "Queueing Systems, Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.
3.	Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993
4.	Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill, 1987

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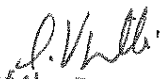| 1.	https://www.youtube.com/watch?v=Y4tOm5rdmtY
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18COE41	Spread Spectrum Communication	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To understand the basics of spread spectrum communication systems.
2.	To learn about the performance of spread spectrum in multipath environment
3.	To understand the way in which spread spectrum is applied to CDMA and GPS systems.

Unit I	SPREADING CODES	9	+	0

Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of ShiftRegister Generators-Generation &Properties of m-Sequences Gold Codes - Kasami Sequences (Small Set) - Quaternary Sequences - Complementary Code Keying - Walsh–Hadamard Sequences.

Unit II	SPREAD SPECTRUM SYSTEMS	9	+	0

Direct Sequence Spread Spectrum (DSSS)- Processing Gain- Frequency Hop Spread Spectrum (FHSS)- Coherent & Noncoherent Slow FHSS – Coherent & Noncoherent Fast FHSS- Hybrid DS/FH Spread Spectrum.

Unit III	SYNCHRONIZATION IN SPREAD SPECTRUM	9	+	0

Baseband Recovery - Carrier Synchronization - Code Synchronization – Code Acquisition & Tracking.

Unit IV	SPREAD SPECTRUM IN MULTIPATH ENVIRONMENT	9	+	0

Performance in Jamming Environment – Low Probability of Detection –Mitigation of Multipath Effects using spread spectrum-RAKE Receiver-CDMA

Unit V	GLOBAL POSITIONING SYSTEM	9	+	0

GPS Principles-NAVSTAR constellation- Gold codes-Synchronization-Differential GPS

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	To be able to arrive at detailed specifications of the spread spectrum systems.
CO2	:	To design systems based on spread spectrum to mitigate the jamming and multipath effect.
CO3	:	To design the spread spectrum based systems for CDMA and GPS.
CO4	:	To Know the concept of Global positioning system.

Text Books:

1.	Rodger E. Ziemer, "Fundamentals of Spread Spectrum Modulation", Morgan & Claypool, Publishers series, 2007.
2.	Bernard Sklar & Pabitra Kumar Ray, "Digital Communications Fundamentals and Applications", Second Edition, Pearson Education, Inc, 2001.

Reference Books:

1.	Robert C.Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994..
2.	L. Peterson, R. E. Ziemer, and D. E. Borth, "Introduction to Spread Spectrum Communications", Upper Saddle River, NJ: Prentice Hall, 1995
3.	M.K. Simon, J.K. Omura, R.A. Scholtz, and B.K. Levitt, "Spread Spectrum Communications Handbook", Electronic Edition, McGraw-Hill, 2002
4.	Doutorialspoint.com/digital_communication/digital_communication_spread_spectrum_modulation.htmn Torrieri, "Principles of Spread-Spectrum Communication Systems", Springer Science, Business Media, Inc Boston, 2005.

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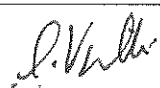| 1.	https://nptel.ac.in/courses/117105077/
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3.	https://www.tutorialspoint.com/digital_communication/digital_communication_spread_spectrum_modulation.htm

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18COE42	MIMO SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To give comprehensive coverage of coding techniques for Multiple Input, Multiple Output (MIMO) communication systems.
2.	To study about MIMO communication systems, Space-time block codes, Space-time trellis codes
3.	To gain knowledge on MIMO systems for frequency-selective (FS) fading channels.

Unit I	FADING CHANNELS AND DIVERSITY TECHNIQUES	9	+	0

Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

Unit II	CAPACITY AND INFORMATION RATES OF MIMO CHANNELS	9	+	0

Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signalling for MIMO communications.

Unit III	SPACE-TIME BLOCK AND TRELLIS CODES	9	+	0

Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal space-time block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes

Unit IV	CONCATENATED CODES AND ITERATIVE DECODING	9	+	0

Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

Unit V	SPACE-TIME CODING FOR FREQUENCY SELECTIVE FADING CHANNELS	9	+	0

MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space-time coding and Channel detection for MIMO FS channels – MIMO OFDM systems

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the diversity techniques and design the MIMO channels
CO2	:	Analyse the performance of for Space time Trellis code.
CO3	:	Design concatenated codes.
CO4	:	Understand Frequency selective channels

Text Books:

1.	Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication systems", John Wiley & Sons, West Sussex, England, 2007
2.	A.B. Gershman and N.D. Sidiropoulus, "Space-time processing for MIMO communications", Wiley, Hoboken, NJ, USA, 2005.

Reference Books:

1.	E.G. Larsson and P. Stoica, "Space-time block coding for Wireless communications", Cambridge University Press, 2003.
2.	M. Janakiraman, "Space-time codes and MIMO systems", Artech House, 2004.
3.	H. Jafarkhani, "Space-time coding: Theory & Practice", Cambridge University Press, 2005.

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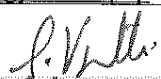| 1.	https://nptel.ac.in/noc/individual_course.php?id=noc17-cs37
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3	https://nptel.ac.in/noc/individual_course.php?id=noc16-ec11

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18COE43	HIGH PERFORMANCE NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To know the different types of networks
2.	To describe the VOIP system
3.	To study VPN remote Access

Unit I	TYPES OF NETWORKS	9	+	0

Types of Networks, Network design issues, Data in support of network design. Network design tools, protocols and architecture. Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, and RSVP-differentiated services.

Unit II	VOIP SYSTEM	9	+	0

VoIP system architecture, protocol hierarchy, Structure of a voice endpoint, Protocols for the transport of voice media over IP networks. Providing IP quality of service for voice, signaling protocols for VoIP, PSTN gateways, VoIP applications.

Unit III	VPN-REMOTE-ACCESS	9	+	0

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections

Unit IV	TRAFFIC MODELING	9	+	0

Traffic Modeling: Little's theorem, Need for modeling, Poisson modeling, Non-poissonmodels, Network performance evaluation..

Unit V	NETWORK SECURITY AND MANAGEMENT	9	+	0

Network Security and Management: Principles of cryptography, Authentication, integrity, key distribution and certification, Access control and fire walls, attacks and counter measures, security in many layers.Infrastructure for network management, The internet standard management framework – SMI, MIB, SNMP, Security and administration, ASN.1.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Apply knowledge of mathematics, probability, and statistics to model and analyze some Networking protocols.
CO2	:	Design, implement, and analyze computer networks.
CO3	:	Identify, formulate, and solve network engineering problems.
CO4	:	Show knowledge of contemporary issues in high performance computer networks.

Text Books:

1.	Kershenbaum A., "Telecommunications Network Design Algorithms", Tata McGraw Hill, 1993
2.	Larry Peterson & Bruce David, "Computer Networks: A System Approach", MorganKaufmann, 2003

Reference Books:

1.	Douskalis B., "IP Telephony: The Integration of Robust VoIP Services", Pearson Ed. Asia, 2000.
2.	Warland J., Varaiya P., "High-Performance Communication Networks", Morgan Kaufmann, 1996.
3.	Stallings W., "High-Speed Networks: TCP/IP and ATM Design Principles", Prentice Hall, 1998.
4.	Leon Garcia, Widjaja, "Communication networks", TMH 7threprint 2002.

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2.	http://nptel.ac.in/courses/106105082/33
3.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/lecture-notes/

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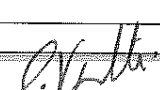Government College of Engineering
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18COE51	COGNITIVE RADIO	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To enable the student to understand the requirements in designing software defined radios and cognitive radio and its functionalities
2.	To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
3	To expose the student to the evolving next generation wireless networks and their associated challenges.

Unit I	INTRODUCTION TO COGNITIVE RADIOS	9	+	0

Motivation, Cognitive radio, Spectrum policy, Data explosion, Applications, Cognitive radio network design, Hardware and system design considerations, Spectrum coexistence, Prototyping and Standardization, Cognitive radio network paradigms, Spectrum sensing.

Unit II	SDR ARCHITECTURE	9	+	0

Software Defined Radio: Evolution - essential functions of the Software Defined Radio - architecture goals - quantifying degrees of programmability - top level component topology - computational properties of functional components - interface topologies among plug and play modules - architecture partitions - merits and demerits of SDR - problems faced by SDR.

Unit III	CR ARCHITECTURE	9	+	0

Cognitive Radio Network Architectures, Topology - Aware CRN Architectures, Publish-Subscribe CRN Architecture,

Unit IV	CRN SECURITY	9	+	0

Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V	NEXT GENERATION WIRELESS NETWORKS	9	+	0

The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.

Total (L+T)= 45 Periods

Course Outcomes:

After the successful completion of the course, the students will be able to

CO1	:	Understand the concepts and design of cognitive radios.
CO2	:	Study about the SDR architecture and analysis.
CO3	:	Analyse the various cognitive radio network architectures
CO4	:	Study the impact of the evolved solutions in future wireless network design.

Text Books:

1.	Alexander M. Wyglinski, MaziarNekovee, and Thomas Hou Y, "Cognitive Radio Communications and Networks - Principles and Practice", Elsevier Inc., 2010
2.	Kwang-Cheng Chen and Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons Ltd, 2009

Reference Books:

1.	Arslan H, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", University of South Florida, USA, Springer, 2007.
2.	Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series: Analog Circuits and Signal Processing, 2009.
3.	Mitola J, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
4	E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, "Principles of Cognitive Radio", Cambridge University Press, 2013.

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1.	http://www.wirelessinnovation.org/Cognitive_Radio_Architecture
2.	http://www.xgtechnology.com/innovations/cognitive-radio-networks/
3.	http://www.radio-electronics.com/info/rf-technology-design/cognitive-radio-cr/technologytutorial.php

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18COE52	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To understand the fundamentals of Internet of Things and its protocols.
2.	To build a small low cost embedded system using Raspberry Pi.
3.	To apply the concept of Internet of Things in the real world scenario.

Unit I	INTRODUCTION TO IOT	9	+	0

Internet of Things – Physical Design – Logical Design – IoT Enabling Technologies –IoT Levels and Deployment Templates – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF-YANG – IoT Platforms Design Methodology

Unit II	IOT ARCHITECTURE	9	+	0

ETSI M2M architecture – IETF architecture for IoT – OGC architecture – IoT reference model – Domain model – Information model – Functional model – Communication model – IoT reference architecture

Unit III	IOT PROTOCOLS	9	+	0

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – Zigbee Architecture – Network layer – 6LowPAN – CoAP – Security

Unit IV	BUILDING IOT WITH RASPBERRY PI AND ARDUINO	9	+	0

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

Unit V	CASE STUDIES AND REAL-WORLD APPLICATIONS	9	+	0

Real world design constraints – Applications – Asset management – Industrial automation – Smart grid – Commercial building automation – Smart cities – Participatory sensing – Data Analytics for IoT

Total (L+T)=45 Periods

Course Outcomes:

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

CO1	:	Understand the fundamentals of IoT.
CO2	:	Analyse various protocols for IoT.
CO3	:	Design a portable IoT using Rasperry Pi.
CO4	:	Analyse applications of IoT in real time scenario.

Text Books:

1.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
2.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Reference Books:

1.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
2.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3.	Hakima Chaouchi, "The Internet of Things Connecting Objects", John Wiley and Sons, 2010.
4.	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things Applications to the smart grid and building automation", John Wiley and Sons, 2012.

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2.	https://nptel.ac.in/courses/108108098/4
3.	https://www.classcentral.com/course/nptel-introduction-to-internet-of-things-10093

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18COE53	VLSI for Wireless Communication	L	T	P	C
		3	0	0	3

Course Objectives:

1	To understand the concepts of basic wireless communication concepts.
2	To study the parameters in receiver, low noise amplifier design and various types of mixers designed for wireless communication.
3	To study and design PLL and VCO and to understand the concepts of transmitters and power amplifiers in wireless communication.

Unit I	WIRELESS COMMUNICATION CONCEPTS	9	+	0

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

Unit II	RECEIVER ARCHITECTURE AND LOW NOISE AMPLIFIERS	9	+	0

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure and Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching and Core amplifier.

Unit III	MIXERS	9	+	0

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer - Switching Mixer – Distortion, Conversion Gain and Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer - Sampling Mixer - Conversion Gain, Distortion, Intrinsic and Extrinsic Noise in Single ended sampling Mixer.

Unit IV	FREQUENCY SYNTHESIZERS	9	+	0

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters and design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

Unit V	TRANSMITTER ARCHITECTURES AND POWER AMPLIFIERS	9	+	0

Transmitter back end design – Quadrature Local Oscillator generator – Power amplifier design.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the fading concepts
CO2	:	Design Low Noise amplifier and Mixers
CO3	:	Evaluate the performance of Frequency synthesizers
CO4	:	Design and analyze Power amplifiers

Text Books:

1.	Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.
2.	B.Razavi ,"RF Microelectronics" , Prentice-Hall communication engineering and emerging technologies series, 2012.

Reference Books:

1.	Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 1999
2.	Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design – Circuits & Systems", Kluwer Academic Publishers, 2000.
3.	Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Pub., 1997
4.	Thomas H.Lee, "The Design of CMOS Radio – Frequency Integrated Circuits", Cambridge University Press ,2003.

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2.	http://www.nptelvideos.in/2012/12/wireless-communication.html
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18COE61	REMOTE SENSING	L	T	P	C
		3	0	0	3

Course Objectives:

1.	To introduce remote sensing systems
2.	To gain knowledge on image processing techniques for remote sensing
3.	To know various applications of remote sensing

Unit I	INTRODUCTION AND BASIC CONCEPTS OF REMOTE SENSING SYSTEMS	9	+	0

Introduction, Basic concepts of remote sensing, Airborne and space born sensors, Passive and active remote sensing, EMR Spectrum, Energy sources and radiation principles, Energy interactions in the atmosphere, with earth surfaces, Satellites and orbits, Polar orbiting satellites, Multispectral, thermal and hyperspectral sensing, Some remote sensing satellites and their features.

Unit II	IMAGE PROCESSING SYSTEM AND DISPLAY	9	+	0

Image Processing System Characteristics, The Histogram and Its Significance, Univariate, Multivariate Image Statistics, Black-and-White Hard-Copy Image Display, Temporary Video Image Display, Merging Different Types of Remotely Sensed Data , Transforming Video Displays to Hard-Copy Displays.

Unit III	IMAGE PREPROCESSING	9	+	0

CORRECTION AND ENHANCEMENT: Radiometric Correction, Geometric Correction of Remote Sensor Data, Image Reduction and Magnification, Contrast Enhancement, Band Rationing, Spatial Filtering to Enhance Low- and High-Frequency Detail and Edges, Special Transformations.

Unit IV	THEMATIC INFORMATION EXTRACTION AND DIGITAL IMAGE CLASSIFICATION	9	+	0

Image Classification, Supervised Classification, The Classification Stage, The Training Stage, Unsupervised Classification, Hybrid Classification of Mixed Pixels, The Output Stage and Post classification, Object-Based Classification, Neural Network Classification, Classification Accuracy, Assessment Change Detection, Image Time Series Analysis, Data Fusion and GIS

Unit V	CASE STUDY: APPLICATIONS OF REMOTE SENSING	9	+	0

Introduction, Land Use/Land Cover Mapping, Geologic and Soil Mapping Agricultural Applications, Forestry Applications, Rangeland Applications, Water Resource Applications, Snow and Ice Applications, Urban and Regional Planning Applications, Wetland Mapping, Wildlife Ecology Applications Archaeological Application

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand the basics of remote sensing systems.
CO2	:	Apply image processing techniques in the area of remote sensing
CO3	:	Extract and analyse thematic information using image analysis techniques
CO4	:	Implement various remote sensing applications using the learnt technique.

Text Books:

1.	John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective"", Pearson, 2017.
2.	Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman,"Remote Sensing and Image Interpretation" , Wiley, 2017
3.	Richards John A& Xiuping Xia, "Remote Sensing Digital Image Analysis: An Introduction", Springer-Verlag, 2013

Reference Books:

1.	Gonzalez Rafael C and Woods Richard E," Digital Image Processing Addison Wesley, New York , Pearson, 2007
2.	Robert Grier Reeves,"Manual of Remote Sensing: American Society of Remote Sensing and Photogrammetry", American Society of Photogrammetry , 2007

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1.	https://oceanservice.noaa.gov/facts/remotesensing.html
2.	https://gisgeography.com/remote-sensing-earth-observation-guide/

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18COE62	WAVELET SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To expose the students to the basics of wavelet theory.
2.	To illustrate the use of wavelet processing for data compression.
3.	To expose the students to use the wavelet processing for noise suppression.

Unit I	Windowed Fourier transform	9	+	0

Limitations of standard Fourier analysis. Windowed Fourier transform. Continuous wavelet transform. Time-frequency resolution.

Unit II	Wavelet transform	9	+	0

Wavelet basics. Balian-Low theorem. Multiresolution analysis. (MRA). Construction of wavelets from MRA. Fast wavelet algorithm.

Unit III	Wavelet packets	9	+	0

Compactly supported wavelets. Cascade algorithm. Franklin and spline wavelets. Wavelet packets.
Hilbert space frames. Frame representation. Representation of signals by frames. Iterative reconstruction. Frame algorithm.

Unit IV	Noise suppression	9	+	0

Wavelet methods for signal processing. Noise suppression. Representation of noise-corrupted signals using frames. Algorithm for reconstruction from corrupted frame representation.

Unit V	Wavelet methods for image processing	9	+	0

Wavelet methods for image processing. Burt- Adelson and Mallat's pyramidal decomposition schemes. 2D-dyadic wavelet transform.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform.
CO2	:	Understand wavelet basis and characterize continuous and discrete wavelet transforms
CO3	:	Understand multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties
CO4	:	Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.

TEXT BOOKS:

1.	E.Hernandez & G.Weiss, A First Course on Wavelets, CRC Press, 1996.
2	L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

Reference Books:

1	A.Teolis, Computational Signal Processing with Wavelets, Birkhauser, 1998
2	R.M. Rao & A.S. Bopardikar, Wavelet Transforms, Addition Wesley, 1998.
3	J.C. Goswami & A.K. Chan, Fundamentals of Wavelets, John Wiley,1999.
4	Recent literature in Wavelet Signal Processing.

E-Reference

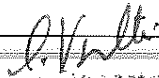| 1.	https://web.stanford.edu/class/energy281/WaveletAnalysis.pdf
2.	https://nptel.ac.in/course.html
3.	https://www.youtube.com/watch?v=5kpBz5pV_8Q-Mod-01 Lec-04 Wavelets And Multirate Digital Signal Processing

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18COE63	BIO MEMS		L	T	P	C
			3	0	0	3

COURSE OBJECTIVES:

1.	To train the students in the design aspects of Bio MEMS devices and Systems.
2.	To make the students aware of applications in various medical specialists.
3.	To aware the students to compare the conventions methods and Bio MEMS usage.

Unit I	BIO MEMS-INTRODUCTION AND FABRICATION	9	+	0

Introduction-The driving force behind Biomedical Applications – Biocompatibility - Reliability Considerations-Regularity Considerations – Organizations - Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques

Unit II	MICRO FLUIDIC PRINCIPLES	9	+	0

Introduction-Transport Processes- Electro kinetic Phenomena-Micro valves –Micro mixers- Micro pumps.

Unit III	SENSOR PRINCIPLES and MICRO SENSORS	9	+	0

Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine.

Unit IV	MICRO ACTUATORS and DRUG DELIVERY	9	+	0

Introduction-Activation Methods-Micro actuators for Micro fluidics-equivalent circuit representation-Drug Delivery.

Unit V	MICRO TOTAL ANALYSIS	9	+	0

Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems.Detection and Measurement Methods-Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards.

Total (L+T)= 45 Periods

Course Outcomes:

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

CO1	:	Learn and realize the MEMS applications in Bio Medical Engineering.
CO2	:	Understand the Micro fluidic Principles and study its applications.
CO3	:	Learn the applications of Sensors in Health Engineering.
CO4	:	Learn the principles of Micro Actuators and Drug Delivery system and applications of Micro Total Analysis.

TEXT BOOKS:

1.	Steven S. Saliterman, Fundamentals of Bio MEMS and Medical Micro devices, Wiley Interscience, 2006.
2.	G.T. A. Kovacs, "Micro machined Transducers Sourcebook", 1998.

REFERENCE BOOKS:

1	Albert Folch , Introduction to Bio MEMS, CRC Press, 2012.
2	Gerald A. Urban, Bio MEMS, Springer, 2006.
3	Wanjun wang, steven A. Soper, Bio MEMS, 2006.
4	M. J. Madou, "Fundametal of Micro fabrication", 2002.

E-Reference

1.	https://nptel.ac.in/courses/112104181/
2.	https://nanohub.org/resources/992/download/2005.02.07-Bashir1.pdf
3.	https://spie.org/samples/PM153.pdf

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18COE64	BIG DATA TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.	To learn the basics of Big Data and concept of map reduce.
2.	To build and maintain reliable, scalable, distributed systems with Apache Hadoop.
3	To understand Hadoop ecosystem components and YARN.

UNIT I	INTRODUCTION TO BIG DATA	9	+	0

Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.

UNIT II	INTRODUCTION TO HADOOP	9	+	0

Big Data – Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.

UNIT III	HADOOP ARCHITECTURE	9	+	0

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.

UNIT IV	HADOOP ECOSYSTEM AND YARN	9	+	0

Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features- Name Node High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

UNIT V	HIVE AND HIVEQL, HBASE	9	+	0

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

Total = 45 Periods

COURSE OUTCOMES:

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

CO1	:	Understand basics of Big Data and map reduce
CO2	:	Understand HADOOP architecture
CO3	:	Analyze the HADOOP Ecosystem and YARN
CO4	:	Understand the basics of HIVE,HIVEQL,HBASE

REFERENCE BOOKS:

1.	Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
2.	Chris Eaton, Dirk deroos et al. , "Understanding Big data", McGraw Hill, 2012.
3.	Tom White, "HADOOP: The definitive Guide", O Reilly 2012.
4.	Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packet Publishing 2013.
5.	Tom Plunkett, Brian Macdonald et al, "Oracle Big Data Handbook", Oracle Press, 2014
6.	Jay Liebowitz, "Big Data and Business analytics", CRC press, 2013.

E - Reference

| 1.. | http://www.bigdatauniversity.com/ |

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