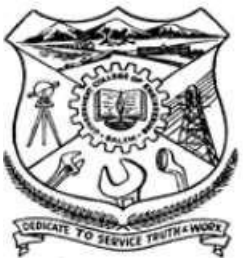

GOVERNMENT COLLEGE OF ENGINEERING
SALEM – 636 011

(An Autonomous Institution affiliated to Anna University- Chennai)

Regulations 2022 - Autonomous Courses(For Students Admitted from 2022 – 2023)

DEPARTMENT OF Electronics and Communication Engineering

CURRICULUM & SYLLABUS
(Choice based credit system)

M.E. Communication Systems

GOVERNMENT COLLEGE OF ENGINEERING SALEM – 636011
(An Autonomous Institution, Affiliated to Anna University, Chennai)

Regulations 2022 – Autonomous Courses
(For Students Admitted from 2022-2023)

M.E. COMMUNICATION SYSTEMS

SEMESTER I

Sl.No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
THEORY										
1.	22COC11	Antennas and Radiating Systems	Core	3	0	0	3	40	60	100
2.	22COC12	Advanced Digital Communication Techniques	Core	3	0	0	3	40	60	100
3.	22COE1X	**Elective – I**	Elect 1	3	0	0	3	40	60	100
4.	22COE2X	**Elective – II**	Elect 2	3	0	0	3	40	60	100
5.	22MLC01	Research Methodology and IPR	MLC	3	0	0	3	40	60	100
	PRACTICAL									
6.	22CO**C**13	Antennas and Radiating Systems lab	Core	0	0	4	2	60	40	100
7.	22CO**C**14	Advanced Digital Communication Systems Lab	Core	0	0	4	2	60	40	100
	Mandatory Course (Non-Credit)									
8.	22AC1x	Audit Course 1	Audit	0	0	0	0	100	0	100
		TOTAL		**15**	**0**	**8**	**19**	**420**	**380**	**800**

SEMESTER II

THEORY

Sl.No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	22CO**C**21	RF and Microwave Circuit Design	Core	3	0	0	3	40	60	100
2.	22CO**C**22	Advanced Digital Signal Processing	Core	3	0	0	3	40	60	100
3.	22COE3X	Elective – III	Elect 3	3	0	0	3	40	60	100
4.	22COE4X	Elective – IV	Elect 4	3	0	0	3	40	60	100

5.	22COE5X	Elective – V	Elect 5	3	0	0	3	40	60	100
PRACTICAL										
6.	22COC23	Advanced Digital Signal Processing Lab	Core	0	0	4	2	60	40	100
7.	22COC24	Mini Project		0	0	4	2	60	40	100
	Mandatory Course (Non-Credit)									
8.	22AC2X	Audit course 2	Audit	0	0	0	0	100	0	100
		TOTAL		**15**	**0**	**8**	**19**	**420**	**380**	**800**

SEMESTER III

THEORY

Sl.No	**Course code**	**Name of the Course**	**Hours/week**					**Maximum Marks**		
			Category	**Lecture**	**Tutorial/ Demo***	**Practical**	**Credits**	**CA**	**FE**	**Total**
1.	22COE6X	Elective – VI	Elect 6	3	0	0	3	40	60	100
2.	22COE7X	Elective – VII	Elect 7	3	0	0	3	40	60	100
PRACTICAL										
3.	22CO301	Dissertation Phase – I		0	0	20	10	120	80	200
		TOTAL		**6**	**0**	**20**	**16**	**200**	**200**	**400**

SEMESTER IV

PRACTICAL

Sl.No	**Cours ecode**	**Name of the Course**	**Hours/week**					**Maximum Marks**		
			Category	**Lecture**	**Tutorial/ Demo***	**Practical**	**Credits**	**CA**	**FE**	**Total**
1.	22CO401	Dissertation Phase – II		0	0	32	16	240	160	400
		TOTAL		**0**	**0**	**32**	**16**	**240**	**160**	**400**

Total Credits for the programme = 19 +19+16+16=70

LIST OF ELECTIVES FOR M.E. COMMUNICATION SYSTEMS

Professional Electives (PE)

Sl.No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
Elective - I										
1.	22COE11	Multimedia Compression Techniques	PE	3	0	0	3	40	60	100
2.	22COE12	Advanced Communication Networks	PE	3	0	0	3	40	60	100
3.	22COE13	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
4.	22COE14	Deep Learning	PE	3	0	0	3	40	60	100
Elective - II										
5.	22COE21	Signal Detection and Estimation	PE	3	0	0	3	40	60	100
6.	22COE22	Optical Networks	PE	3	0	0	3	40	60	100
7.	22COE23	Satellite Communication and Navigation Systems	PE	3	0	0	3	40	60	100
8.	22COE24	Cloud Computing Technologies	PE	3	0	0	3	40	60	100
Elective - III										
9.	22COE31	Wireless and Mobile Communication	PE	3	0	0	3	40	60	100
10.	22COE32	Pattern Recognition and Machine learning	PE	3	0	0	3	40	60	100
11.	22COE33	Voice and data networks	PE	3	0	0	3	40	60	100
12.	22COE34	Digital Image and Video Processing	PE	3	0	0	3	40	60	100
Elective - IV										
13.	22COE41	Spread Spectrum Communication	PE	3	0	0	3	40	60	100
14.	22COE42	MIMO System	PE	3	0	0	3	40	60	100
15.	22COE43	High Performance Networks	PE	3	0	0	3	40	60	100
16.	22COE44	5G Communication Networks	PE	3	0	0	3	40	60	100
Elective - V										
17.	22COE51	DSP Architecture	PE	3	0	0	3	40	60	100
18.	22COE52	Electromagnetic Interference and Compatibility	PE	3	0	0	3	40	60	100
19.	22COE53	Radar Signal Processing	PE	3	0	0	3	40	60	100

20.	22COE54	Natural Language Processing	PE	3	0	0	3	40	60	100
Elective - VI										
21.	22COE61	Cognitive Radio	PE	3	0	0	3	40	60	100
22.	22COE62	Internet of Things	PE	3	0	0	3	40	60	100
23.	22COE63	VLSI for Wireless Communication	PE	3	0	0	3	40	60	100
24.	22COE64	Cryptography and Network Security	PE	3	0	0	3	40	60	100
Elective - VII										
25.	22COE71	Remote Sensing	PE	3	0	0	3	40	60	100
26.	22COE72	Wavelet signal processing	PE	3	0	0	3	40	60	100
27.	22COE73	Bio Mems	PE	3	0	0	3	40	60	100
28.	22COE74	Big Data Technologies	PE	3	0	0	3	40	60	100
List of Audit Course										
1.	22AC11	Stress Management	PE	2	0	0	0	100	0	100
2.	22AC12	Disaster Management	PE	2	0	0	0	100	0	100
3.	22AC13	Constitution of India	PE	2	0	0	0	100	0	100
4.	22AC21	English for Research Paper Writing	PE	2	0	0	0	100	0	100
5.	22AC22	Pedagogy Studies	PE	2	0	0	0	100	0	100
6.	22AC23	Personality Development through Life Enlightenment Skills.	PE	2	0	0	0	100	0	100

22COC11	ANTENNAS AND RADIATING SYSTEMS	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To know the different types of antennas and fundamental parameters.
2	To describe the various linear wire antennas, loop antennas, reflector antennas and arrays
3	To familiarise with modern antennas and measurement techniques

Unit I	ANTENNA FUNDAMENTALS & WIRE ANTENNAS	9	0	0	9

Types of Antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas, Friis Transmission equation. Linear Wire Antennas: Infinitesimal dipole, small dipole, half wave dipole, Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Unit II	LINEAR ARRAYS	9	0	0	9

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 III	APERTURE AND HORN ANTENNAS	9	0	0	9

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

Unit IV	REFLECTOR AND MICRO STRIP ANTENNAS	9	0	0	9

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.

Unit V	MODERN ANTENNAS & MEASUREMENT TECHNIQUES	9	0	0	9

Base station antennas, PIFA – Antennas for WBAN – RFID Antennas – Automotive antennas, MIMO antennas, Diversity techniques – Antenna impedance and radiation pattern measurements.

Total (45 L) = 45 Periods

Text Books:

1	John D.Kraus and Ronalatory Marhefka, "Antennas", Tata McGraw-Hill Book Company, 2010.
2	Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 2012.

Reference Books:

1	E.C. Jordan & K.G. Balmain, "Electromagnetic waves & Radiating Systems", Prentice Hall, India, Reprint 2010.
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-Reference:	
1	https://nptel.ac.in/courses/108101092
2	https://onlinecourses.nptel.ac.in/noc22_ee63
3	Microwave engineering and antennas | Coursera

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Compute the far field distance, radiation pattern and gain of an antenna for given current Distribution.	Evaluate
CO2	Design antennas and antenna arrays for various desired radiation pattern characteristics.	Apply
CO3	Understand the capability and assess the performance of various antennas.	Understand
CO4	Identify the antennas specific to the applications and understand antenna measurement techniques.	Analyse

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1				2	2
CO2	2			3	2
CO3	2			3	3
CO4	2			3	3
Avg	1.5			2.75	2.5
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COC12	ADVANCED DIGITAL COMMUNICATION TECHNIQUES	Semester			I
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To make the students understand the different modules in the digital communication system with mathematical and geometrical 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	**CODED DIGITAL COMMUNICATION SYSTEMS**	**9**	**0**	**0**	**9**

Digital communication system model (description of different modules of the block diagram) - Gram-Schmidt Orthogonalisation procedure - Geometric Interpretation of signals - Coded digital communication systems architectures – Interleaving & deinterleaving to mitigate channel memory- synchronization of I-D systems- Coded system architecture for channels with memory .

Unit II	**DETECTION AND ESTIMATION**	**9**	**0**	**0**	**9**

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

Unit III	**COMMUNICATION OVER BANDLIMITED CHANNELS**	**9**	**0**	**0**	**9**

Definition and characterization of a band limited channel –Optimum pulse shaping design for Digital signalling through band limited AWGN channels- Nyquist Criterion for zero ISI – Eye pattern of a band limited communication systems –systems with controlled ISI –Optimum demodulation of digital signals in the presence of ISI and AWGN - Equalization techniques: Fundamentals- Survey of equalization techniques - zero-forcing linear equalizer-mean squre error linear equalizer- decision feedback equalization

Unit IV	**DIGITAL MODULATION TECHNIQUES**	**9**	**0**	**0**	**9**

Digital Modulation Formats - Coherent Binary Modulation Techniques: Generation – Detection - Signal space diagram - Bit error probability - Power spectra and waveforms of BPSK, BFSK, QPSK and MSK schemes – Non coherent orthogonal binary modulation techniques - Comparison of binary and quaternary modulation techniques using single carrier – Introduction to M-ary Modulation techniques

Unit V	**BLOCK AND CONVOLUTIONAL CODED DIGITAL COMMUNICATION**	**9**	**0**	**0**	**9**

Linear 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 decoding of convolutional codes - Viterbi algorithm methods – 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 (45L) = 45 Periods

Text Books:

1	Simon Haykin, 'Digital Communications ', John Wiley & sons, 2014

2	Marvin K Simon, Sami M Hinedi , William C Lindsey , 'Digital Communication Techniques- signal design and detection'. PHI Learning, 2014
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	Theodore S.Rappaport "Wireless Communications: Principles and Practice', 2nd Edition, Pearson, 2012.
4	Wayne Tomasi, 'Advanced Electronic Communication Systems, 6th Edition., Pearson Education, 2014.
e-Reference:	
1	https://en.wikipedia.org/wiki/Gram–Schmidt_process
2	https://books.google.co.in/books?isbn=0070591172
3	https://nptel.ac.in › courses

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply the knowledge of mathematical models of channels in the design of Digital Communication systems.	Apply
CO2	Classify the different receiver used in the digital communication systems.	Understand
CO3	Analyse the eye patterns and can select the algorithm for equalizer to reduce ISI.	Analyse
CO4	Design a digital modulator and can generate codes for error free communication.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	2	1
CO2	2		1	2	1
CO3	2		1	2	1
CO4	2		1	2	1
Avg	2		1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COC13	ANTENNAS AND RADIATING SYSTEMS LAB	Semester			I
PREREQUISITES	Category	PC	Credit		2
	Hours/Week	L	T	P	TH
		0	0	4	4

Course Learning Objectives

1	Determine specifications, design, construct, and test antenna
2	Study the characteristics of patch antennas.
3	Able to simulate MIMO antennas and to study its various parameters.

EXPERIMENTS

1.	Radiation Pattern Measurement of Dipole and monopole Antenna.
2.	Measure the Radiation Pattern of Loop Antenna.
3.	Design and study the radiation pattern of Broad side and End Fire Array.
4.	Measure the Radiation pattern of Horn Antenna.
5.	Design of Rectangular Microstrip Patch antenna (RMSA) with different feed techniques viz., edge, inset.
6.	Design of Rectangular Microstrip Patch antenna (RMSA) using coaxial probe feed.
7.	Design circular microstrip antenna
8.	Study the effect of slots in microstrip antenna
9.	Design of a Frequency reconfigurable antenna
10.	Design a two element MIMO antenna and obtain its diversity performance factors

Total (P)= 60 Periods

Text 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.

Reference Books:

1.	https://www.academia.edu/3356546/High_Frequency_Structure_Simulator_HFSS_Tutorial
2.	https://www.researchgate.net/publication/322726818_Microstrip_Antennas
3.	Engineering tutorial center - YouTube

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use HFSS to simulate different types of antennas.	Apply
CO2	Design and study the radiation pattern of antennas and arrays	Analyse
CO3	Understand the impact of variation in antenna parameters in radiation pattern.	Understanding
CO4	Differentiate antenna array and MIMO antenna	Analyse

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2			3	2
CO2	3			2	2
CO3	3			2	3
CO4	2			2	3
Avg	2.5			2.25	2.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COC14	ADVANCED DIGITAL COMMUNICATION SYSTEMS LABORATORY	Semester	I

PREREQUISITES	Category	PC	Credit		2
	Hours/Week	L	T	P	TH
		0	0	4	4

Course Learning 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

1.	Generate line codes for the digital signals (NRZ-RZ-Manchester)
2.	Computation of the analytical signal and the Power Spectral Density using Hilbert Transform.
3.	Analysis of the harmonic distortion of a system in the presence of noise.
4.	Matched filter.
5.	Weiner filter.
6.	Eye pattern of a communication system.
7.	Channel Equalizer.
8.	Linear and cyclic codes.
9.	An end-to-end communication link using turbo codes in and AWGN channel and the estimation of the Bit Error Rate.
10.	Generation of all the digital modulation schemes.
11.	Performance evaluation of the M-ary digital modulation techniques
12.	Comparative study of SDR and HDR.

Total (P)= 60 Periods

Text Books:

1	Simon Haykin, 'Digital Communications ', John Wiley & sons, 2014
2	Marvin K Simon, Sami M Hinedi , William C Lindsey , 'Digital Communication Techniques- signal desing and detection'. PHI Learning, 2014

Reference Books:

1	M. K. Simon, S. M. Hinedi and W. C. Lindsey, 'Digital Communication Techniques: Signal Design and detection' Prentice Hall India, N. Delhi, 2015.
2	W. Tomasi, Advanced Electronic Communication Systems, 4th Edition., Pearson Education, 1998.
3	Peyton Z.Peebles, JR, Digital communication systems, Prentice hall

4	Wayne Tomasi, 'Advanced Electronic Communication Systems, 6th Edition., Pearson Education, 2014.
E-References:	
1.	M. K. Simon, S. M. Hinedi and W. C. Lindsey, 'Digital Communication Techniques: Signal Design and detection' Prentice Hall India, N. Delhi, 2015.
2.	W. Tomasi, Advanced Electronic Communication Systems, 4th Edition., Pearson Education, 1998.
3.	Peyton Z.Peebles, JR, Digital communication systems, Prentice hall
1.	https://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/108101091
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Compute and analyse the distortion in the presence of noise and to design filters.	Analyze
CO2	Analyse the system using eye pattern and design equalizer to avoid ISI.	Analyze
CO3	Design an error free system using coding techniques.	Apply
CO4	Select the modulation scheme and able to design system using SDR.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2			2	2
CO2	2			2	2
CO3	2			2	2
CO4	2			2	2
Avg	2			2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COC21	RF AND MICROWAVE CIRCUIT DESIGN	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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	0	9

Importance of RF and Microwave Concepts and Applications- and Units Frequency Spectrum, RF and Microwave Circuit Design, Dimensions - RF Behaviour of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, Types of Transmission Lines-Equivalent Circuit representation- SWR - Voltage reflection co– efficient - propagation constant - phase constant - phase velocity - Smith chart.

Unit II	RF DEVICE AND CIRCUIT	9	0	0	9

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 SYSTEM DESIGN	9	0	0	9

Impedance matching concepts – Microstrip matching – Transistor biasing networks – Amplifier design concepts and power relations – Design of portable systems.

Unit IV	RF FEEDBACK SYSTEMS AND POWER AMPLIFIERS	9	0	0	9

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	RF RESONATORS AND FILTERS	9	0	0	9

Basic Resonator types, transmission line resonators, Resonant waveguide cavities, Excitation of resonators, RF Filters: Basic filter configurations, Special Filter Realizations, Filter Implementation, Coupled Filter

Total (45 L) = 45 Periods

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-Reference:	
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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the behaviour of passive components at very high frequency.	Understand
CO2	Design High Frequency Mixer and Amplifiers.	Apply
CO3	Analyze the performance parameters of RF system design and power amplifiers.	Analyze
CO4	Perform a variety of RF resonators and filters.	Remember

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	1	1
CO2	1	2		2	
CO3	1		2		2
CO4	2	2		1	
Avg	1.5	1	0.75	1	0.75

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COC22	ADVANCED DIGITAL SIGNAL PROCESSING	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To estimate power spectrum using non- parametric and parametric methods.
2	To know about optimum filters and adaptive filtering and its applications
3	To apply the concept of multirate signal processing for various applications

Unit I	DISCRETE RANDOM SIGNAL PROCESSING	9	0	0	9

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean and variance - Auto-covariance and Auto-correlation matrices- Auto covariance and Cross covariance- Properties – White noise process – Wiener Khintchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations

Unit II	SPECTRUM ESTIMATION	9	0	0	9

Estimation of spectra from finite duration signals, Bias and Consistency of estimators - Non- Parametric methods: Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric Methods: AR, MA and ARMA spectrum estimation - Detection of Harmonic signals - Performance analysis of estimators. MUSIC and ESPRIT algorithms.

Unit III	SIGNAL MODELING AND OPTIMUM FILTERS	9	0	0	9

Introduction- Least squares method – Pade approximation – Prony's method – Forward and backward linear prediction – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non-Causal and Causal IIR Wiener Filter -– Discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Unit IV	ADAPTIVE FILTERS	9	0	0	9

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications: Noise cancellation, channel equalization, echo canceller, Adaptive Recursive Filters: RLS adaptive algorithm, Exponentially weighted RLS-sliding window RLS. Matrix inversion Lemma.

Unit V	MULTIRATE DIGITAL SIGNAL PROCESSING	9	0	0	9

Decimation by a factor D - Interpolation by a factor I - Sampling rate conversion by a rational factor I/D, Implementation of Sampling Rate Conversion. Applications of Multirate signal processing - Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Subband Coding of Speech Signals, Implementation of Digital Filter Banks, Quadrature Mirror Filters.

Total (45 L) = 45 Periods

Text Books:

1	Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 2008.
2	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", 4th Edition, Pearson Education, 2013.

Reference Books:

1	P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1992.
2	D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, Artech House Publishers, 2005.
3	Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, 5th Edition, 2014.
4	S. Kay,” Modern spectrum Estimation theory and application”, Pearson India, 2009.
e-Reference:	
1	https://nptel.ac.in/courses/108106136/
2	htts://www.coursera.org/learn/dsp
3	https://nptel.ac.in/courses/117101001

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Analyze discrete time random processes.	Analyze
CO2	Apply appropriate model for estimation and signal modeling for the given problem.	Apply
CO3	Design adaptive filters for different applications.	Apply
CO4	Design discrete time system for the given application using multirate signal processing.	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	2	
CO2	2	1	1	2	2
CO3	2	2	2	2	2
CO4	3	2	2	3	2
Avg	2.25	1.25	1.5	2.25	1.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COC23	ADVANCED DIGITAL SIGNAL PROCESSING LAB	Semester			II
PREREQUISITES		Category	PC	Credit	2
		Hours/Week	L	T	P	TH
			0	0	4	4

Course Learning Objectives	
1	To impart knowledge for implementing various DSP algorithms.
2	To gain knowledge on signal multi-rate processing.
3	To implement FIR and IIR filters.

EXPERIMENTS	
1.	Determination of the 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 (45 L) = 45 Periods

Reference Books:	
1	M. K. Simon, S. M. Hinedi and W. C. Lindsey, 'Digital Communication Techniques: Signal Design and detection' Prentice Hall India, N. Delhi, 2015.
2	W. Tomasi, Advanced Electronic Communication Systems, 4th Edition., Pearson Education, 1998.

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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Compute and analyse the distortion in the presence of noise and to design filters.	Analyse
CO2	Analyse the system using eye pattern and design equalizer to avoid ISI.	Analyse
CO3	Design an error free system using coding techniques.	Analyse
CO4	Select the modulation scheme and able to design system using SDR.	Analyse

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	2	1	2
CO2	2	1	2	1	2
CO3	2	1	2	1	2
CO4	2	1	2	1	2
Avg	2	1	2	1	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE11	MULTIMEDIA COMPRESSION TECHNIQUES	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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 AND MATHEMATICAL PRELIMINARIES	9	0	0	9

Compression Techniques – Modeling and Coding - Overview of information theory –models - coding – Algorithmic information theory - minimum description length principle - Huffman coding algorithms – Non-Binary Huffman codes – Adaptive Huffman coding – Applications of Huffman coding.

Unit II	ARITHMETIC CODING AND DICTIONARY TECHNIQUES	9	0	0	9

Introduction - Coding a sequence – Generating a binary code – Comparison of Huffman and Arithmetic coding - Adaptive arithmetic coding - applications – Introduction to dictionary techniques - Static and Adaptive dictionary : LZ77, LZ78 – Applications – Scalar and Vector Quantization.

Unit III	SUBBAND CODING AND AUDIO COMPRESSION	9	0	0	9

Filters - Basic sub-band coding - Design of filter banks - Application to speech coding - G.722 - Application to audio coding - MPEG audio coding : Layer I , Layer II ,Layer III - MPEG advanced audio coding – speech compression .

Unit IV	TRANSFORM CODING AND IMAGE COMPRESSION	9	0	0	9

Transform coding techniques : KL-DCT-DST- Walsh Hadamard transforms – Application to image compression : JPEG - Wavelet based compression: EZW - SPIHT, JPEG-2000.

Unit V	VIDEO COMPRESSION	9	0	0	9

Motion compensation - Video signal representation — ITU-T recommendation H.261, H 262, H 263 and H 264 – Model based coding - -Asymmetric applications - MPEG standards - Motion estimation techniques : MPEG 4 part 2

Total (45 L) = 45 Periods

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.
4	Wayne Tomasi, ‘Advanced Electronic Communication Systems, 6th Edition., Pearson Education, 2014.

e-Reference:

1	https://www.coursera.org
2	https://onlinecourses.nptel.ac.in
3	https://www.youtube.com/watch?v=rC16fhvXZOo

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Code information using various Lossy and Lossless methods.	Apply
CO2	Apply the concepts dictionary-based coding techniques.	Understand
CO3	Do various analysis on audio compression.	Understand
CO4	Implement image and video compression	Understand

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	2	1
CO2	2		1	2	1
CO3	2		1	2	1
CO4	2		1	2	1
Avg	2		1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE12	ADVANCED COMMUNICATION NETWORKS	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To analyze the performance of network.
2	To gain knowledge on network layer and various routing protocols.
3	To familiarize the functions and protocols of the internet servers.

Unit I	OVERVIEW OF INTERNET	9	0	0	9

Overview of Internet-Concepts, challenges and history. Overview of high speed networks-ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP

Unit II	REAL TIME COMMUNICATIONS OVER INTERNET	9	0	0	9

Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP. Resource Reservation in internet, Characterization of Traffic by Linearly Bounded arrival Processes (LBAP), Leaky bucket algorithm and its properties.

Unit III	PACKET SCHEDULING ALGORITHMS	9	0	0	9

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

Unit IV	IP ADDRESS LOOKUP-CHALLENGES	9	0	0	9

Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Unit V	ADMISSION CONTROL IN INTERNET	9	0	0	9

Concept of effective bandwidth, Measurement based admission control; Differentiated Services in Internet (DiffServ), DiffServ architecture and framework. IPV4, IPV6, IP tunnelling, IP switching and MPLS-Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

Total (45 L) = 45 Periods

Text Books:

1	Jean Wairand and Pravin Varaiya, High Performance Communications Networks, Second Edition, 2000.
2	Jean Le Boudec and Patrick Thiran, Network Calculus A Theory of Deterministic Queueing Systems for the Internet, Springer Veriag, 2001.

Reference Books:

1	Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.

2	Anurag Kumar, D.Manjunath and Joy Kuri,"Communication Networking: An analytical Approach:, Morgan Kaufman Publisher, 2004.
3	George Kesidis." ATM Network Performance: Kluwer Academic, Research Papers, 2005.
4	Nader F,Mir," Computer and Communication Networks", Second Edition, 2015.
e-Reference:	
1	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2002/lecture-notes/
2	http://nptel.ac.in/courses/106105081/1
3	https://youtube.com/playlist?list=PLBlnK6fEyqRgMCUAG0XRw78UA8qnv6jEx

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Design and develop protocols for communication networks.	U
CO2	Analyze and design routing algorithms	A
CO3	Design protocols for various functions in the network.	A
CO4	Optimize network design and identify various IP address challenging.	A

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	1	2	1	1
CO2	1	1	2	2	2
CO3	1	1	2	2	2
CO4	1	1	2	2	2
Avg	1	1	2	1.75	1.75

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE13	WIRELESS SENSOR NETWORKS		Semester			I
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning 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	0	9

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	0	9

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	0	9

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	0	9

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	0	9

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

Total (45 L) = 45 Periods

Text Books:

1	Holger Karl, A 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.
e-Reference:	
1	http://nptel.ac.in/courses/106105160/
2	http://edusparkz.com/course_details?course_id=11142
3	https://ict.iitk.ac.in/courses/wireless-ad-hoc-and-sensor-networks/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Gain knowledge on the basics of wireless sensor networks.	Remember
CO2	Get exposure to network protocol design and apply these principles in the context of wireless sensor networks.	Apply
CO3	Learn various hardware, software platforms that exist for sensor networks.	Understand
CO4	Gain knowledge on various topologies available in wireless sensor networks	Understand

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	2				
CO2	2	1	2	2	2
CO3	2		1	2	2
CO4	2	0.5	1	1	1
Avg	2	1	1	1.25	1.25

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE14	DEEP LEARNING	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain insights on machine learning basics and its challenges
2	To understand and apply deep learning algorithms using keras and Tensor flow
3	To perform object localization, pre-process data and use generative models

Unit I	INTRODUCTION	9	0	0	9

Introduction to deep learning-Applied Math and Machine Learning Basics- Linear Algebra- Probability and Information Theory-Machine Learning Basics- Learning Algorithms- Capacity, Overfitting and Underfitting- Hyperparameters and Validation Sets-Supervised and Unsupervised Learning Algorithms- Challenges and Motivation for Deep learning

Unit II	MODERN PRACTICAL DEEP NETWORKS	9	0	0	9

Deep Feed forward Networks- Regularization for Deep Learning- Optimization for Training Deep Models- Challenges in Neural Network Optimization-Applications-Long Short-Term Memory-Convolutional Neural Network (CNN) – Recurrent Neural Networks (RNN).

Unit III	DEEP CONVOLUTIONAL MODELS	9	0	0	9

Object Detection: Object Localization, Landmark detection, YOLO Algorithm-NLP: Introduction to NLP and deep learning-Simple word vector representations: word2vec, GloVe-Advanced word vector representations- language models, softmax, single layer networks- Neural Networks and back propagation for named entity recognition

Unit IV	GENERATIVE MODELS	9	0	0	9

Restrictive Boltzmann Machines (RBMs)- Introduction to MCMC and Gibbs Sampling- gradient computations in RBMs- Deep Boltzmann Machines. Recent trends: Variational Auto encoders - Generative Adversarial Networks- Multi-task Deep Learning - Multi-view Deep Learning.

Unit V	TOOLS AND APPLICATIONS	9	0	0	9

Introduction to Keras and Tensor flow-Deep learning for computer vision, Deep Learning Applications at the Enterprise Scale, Deep Learning Models for Healthcare Applications- Semantic parsing of Speech using Recurrent Net- LSTM network for sentiment analysis.

Total (45 L) = 45 Periods

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2	Adam Gibson and Josh Patterson,”Deep Learning: A Practitioner's Approach”, 1st Edition,O’Reilly Media,2017

Reference Books:

1	Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013
2	Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.es of deep learning Technique
3	Miguel Morales, Grokking Deep Reinforcement Learning,2020
4	Stephan Raaijmakers,"Deep Learning for Natural Language Processing",Manning, 2022
e-Reference:	
1	https://www.coursera.org/learn/convolutional-neural-networks
2	http://neuralnetworksanddeeplearning.com/
3	(339) Deep Learning Full Course - Learn Deep Learning in 6 Hours | Deep Learning Tutorial | Edureka - YouTube

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use deep learning algorithms for the specific use case.	A
CO2	Practically implement deep networks for suitable real world problems using DL tools	A
CO3	Perform object localization and efficiently pre-process data.	U
CO4	Apply generative models and optimize on real world problems and explore its applications	A

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	2		2	1	3
CO2	2		3		2
CO3	2		2		2
CO4	2		2	2	2
Avg	2		2.25	0.75	2.25
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COE21	SIGNAL DETECTION AND ESTIMATION	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To introduce various decision-making systems.
2	To impart knowledge on Estimation Theory.
3	To gain knowledge of Filtering techniques and Statistical operations.

Unit I	**RANDOM PROCESSES**	**9**	**0**	**0**	**9**

Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes

Unit II	**DETECTION THEORY**	**9**	**0**	**0**	**9**

Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)- minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

Unit III	**LINEAR MINIMUM MEAN-SQUARE ERROR FILTERING**	**9**	**0**	**0**	**9**

Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

Unit IV	**STATISTICS**	**9**	**0**	**0**	**9**

Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

Unit V	**ESTIMATING THE PARAMETERS OF RANDOM PROCESSES FROM DATA**	**9**	**0**	**0**	**9**

Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

Total (45 L) = 45 Periods

Text Books:

1	K. Sam Shanmugan & A.M. Breipohl, “Random Signals: Detection, Estimation and Data Analysis”, Wiley India Pvt. Ltd, 2011.
2	Lonnie C. Ludeman, “Random Processes: Filtering, Estimation and Detection”, Wiley India Pvt. Ltd., 2010.

Reference Books:

1	Steven. M.Kay, “Fundamentals of Statistical Signal Processing: Volume I Estimation Theory”, Prentice Hall, USA, 1998.
2	Srinath, Rajasekaran, Viswanathan, “Introduction to Statistical Signal Processing with Applications”, 2003, PHI.

3	Louis L. Scharf, “Statistical Signal Processing: Detection, Estimation and Time Series Analysis”, 1991, Addison Wesley.
4	Mischa Schwartz, Leonard Shaw, “Signal Processing: Discrete Spectral Analysis – Detection & Estimation”, 1975, McGraw Hill.
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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Characterize and apply probabilistic techniques in modern decision systems.	Analyse
CO2	Demonstrate and compare various Estimation techniques.	Analyse
CO3	Understand statistics of various estimators.	Understand
CO4	Estimate the parameters of random process for the data given.	Analyse

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	1	1	2	2	2
CO2	1	1	2	2	2
CO3	1	1	2	2	2
CO4	1	1	2	2	2
Avg	1	1	2	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE22	OPTICAL NETWORKS	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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	0	9

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

Unit II	TRANSMISSION SYSTEM ENGINEERING	9	0	0	9

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

Unit III	OPTICAL NETWORK ARCHITECTURES	9	0	0	9

Introduction to Optical Networks: 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	0	9

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	0	9

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

Total (45 L) = 45 Periods

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
e-Reference:	
1	https://nptel.ac.in/downloads/117101054/
2	http://ece.eng.wayne.edu/~avrutsky/Teaching/ECE5870/NotesFall10.html
3	Optical Networks Tutorial (tutorialspoint.com)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	To understand the importance of the backbone infrastructure for our present and future communication.	Understand
CO2	To know the concept of system model and optical internets.	Remember
CO3	Analyze the performance of optical networks and network elements.	Analyze
CO4	To be able to arrive at detailed specifications of the network topologies and protection schemes	Understand

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	2	1	1	1	2
CO2		2			1
CO3	2		1	1	1
CO4		1	2	2	
Avg	1	1	1	1	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE23	SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn about the science behind the orbiting satellites and various multiplexing schemes
2	To impart knowledge on earth station parameters used for satellite communication.
3	To gain knowledge of navigation systems especially GPS in detail.

Unit I	ORBITS, PROPAGATION IMPAIRMENTS AND SPACE LINK	9	0	0	9

Introduction, Satellite orbits, Kepler ‘s three laws, Orbital Elements, Eclipse effect, Orbit determination, Look angle determination. Satellite subsystems: Attitude and Orbital Control System (AOCS), Telemetry Tracking and Command (TT&C), Power System, Communications System, Satellite transponder, Space Craft Antennas, Frequency Reuse Antennas. Communication link design: Basic transmission theory, EIRP, Completion Link design with and without frequency reuse, System noise temperature G/T ratio, Noise figure and Noise temperature.

Unit II	SATELLITE MULTIPLE ACCESSES: SATELLITE MOBILE AND SPECIALIZED SERVICES	9	0	0	9

Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N, Time Division Multiple Access (TDMA), Satellite Switched TDMA, Demand Assignment Multiple Access (DAMA), CDMA Spread Spectrum Transmission and Reception. Message Transmission by FDMA: M/G/1 Queue, Message Transmission by TDMA, PURE ALOHA, Satellite Packet Switching, Slotted Aloha, Packet Reservation, Tree Algorithm, VSAT Technologies, Network Configurations, Polling VSAT Networks, Mobile Satellite Networks, CDMA MSAT Network.

Unit III	EARTH STATION TECHNOLOGY	9	0	0	9

Transmitters, Receivers, Antennas, Tracking Systems, Transponders, Small earth station Antennas, Equipment for earth station, Lower Orbit Considerations, Coverage and frequency considerations, Direct broadcasting satellite Television and Radio, Satellite Navigation.

Unit IV	INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSSs)	9	0	0	9

The History of GPS, The Evolution of GPS, Development of NAVSTAR GPS, GPS working principle, Trilateration, Determining the receiver position in 2D or XY Plane, Determining the receiver position in 3D or X-Y-Z Plane.

Unit V	GPS ORBITS AND SATELLITE POSITION DETERMINATION	9	0	0	9

GPS system segments, Space segment, Control segment, User segment, GPS Signals, Pseudorandom noise (PRN) code, C/A code, P code Navigation data, and Signal structure of GPS. Anti-spoofing (AS), selective availability GPS orbital parameters, description of receiver independent exchange format (RINEX) – Observation data and navigation message data parameters, GPS position determination, least squares

Total (45 L) = 45 Periods

Text Books:	
1	Satellite Communications –Timothy Pratt, Charles Bostian, Jeremy Allnutt, 2nd Edition, 2003, John Wiley & Sons.
2	G S RAO, Global Navigation Satellite Systems, McGraw-Hill publications, New Delhi, 2010.
Reference Books:	
1	Satellite Communications - by Dr.D.C.Agarwal.
2	Satellite Communications: Design Principles – M. Richcharia, 2nd Ed., BSP, 2003.
3	James Ba – Yen Tsui, _Fundamentals of GPS receivers – A software approach', John Wiley & Sons (2001).
4	Gunter Seeber., Satellite Geodesy Foundations-Methods and Applications,2003.
e-Reference:	
1	https://youtube.com/playlist?list=PL3rE2jS8zxAxamj-MY7FvzOZkHUALNndQ
2	https://youtube.com/playlist?list=PLAnjLC20C-XQnoowCtt-67WmyxoQPu2Fi
3	https://youtube.com/playlist?list=PLLy_2iUCG87A55NPtEwWoWPiKs0-9NNT1

Course Outcomes:

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

CO1	Architect appropriate technologies for the implementation of specified satellite communication systems based on specific systems designed for satellite communications.
CO2	Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.
CO3	Summarize the working principle of GPS and its history.
CO4	Develop new navigation solutions for determining accurate user position.

COs/POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1		2	1		
CO2	1	2	2	1	1
CO3		2	1		
CO4	1	2	2	1	1
Avg	0.5	2	1.5	0.5	0.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE24	CLOUD COMPUTING TECHNOLOGIES	Semester			I
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To recognize the cloud computing architecture and infrastructure, including SaaS, PaaS, IaaS, public cloud, private cloud, and hybrid cloud.
2	To use commercial cloud computing infrastructures, such as Amazon Web Services, to deploy apps like Microsoft Azure and Google App Engine
3	To apply cloud security to a range of practical applications and analyse the trade-offs between deploying applications on local infrastructure versus the cloud.

Unit I	**INTRODUCTION**	**9**	**0**	**0**	**9**

The Vision of Cloud Computing - Defining a Cloud-A closer look - A Cloud Computing Reference Model - Characteristics and Benefits - Challenges Ahead - Historical Developments - Computing Platforms and Technologies-Principles of parallel and distributed computing- Elements of parallel and distributed computing.

Unit II	**VIRTUALIZATION**	**9**	**0**	**0**	**9**

Introduction - Hypervisors -Main Categories of Virtualization: Full, Para –Characteristics of virtualized environments – Taxonomy of virtualization techniques- Virtualization and cloud computing- Pros and cons of virtualization – Technology examples- Xen, VMWare - Microsoft Hyper-V

Unit III	**CLOUD COMPUTING ARCHITECTURE AND TECHNOLOGIES**	**9**	**0**	**0**	**9**

Introduction-Cloud Reference Model-- SaaS, PaaS, IaaS -Types of clouds- public clouds, private clouds, community clouds and hybrid clouds-Economics of the cloud-Open Challenges.

Unit IV	**CLOUD SECURITY**	**9**	**0**	**0**	**9**

Infrastructure Security: Network level, Host level and Application level –Data Security- Identity and access Management: Architecture and Practices - Security Management in the Cloud - Federation in Cloud - Cloud Storage – Edge Computing.

Unit V	**CLOUD PLATFORMS AND APPLICATIONS**	**9**	**0**	**0**	**9**

Amazon web services-Google Engine-Microsoft Azure-Cloud Applications-Scientific Applications-Business and Consumer Applications.

Total (45 L) = 45 Periods

Text Books:

1	Rajkumar Buyya, Christian Vecchiola and Thamarai SelviS, “Mastering Cloud Computing”, Tata McGraw Hill Education Private Limited,New Delhi,2013.
2	George Resse G., “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud“ , First Edition ,O’ Reilly.2009

Reference Books:

1	Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-On Approach”,2014
2	Sosinsky B., “Cloud Computing Bible”, Wiley India Pvt Ltd, 2011
3	Chen, Lei, Le-Khac, Nhien-An, Takabi, Hassan , “Security, privacy and digital forensics in the cloud”, John Wiley & Sons, 2019.
4	Tim Mather, Subra Kumarasamy and Shahed Latif,“Cloud Security and Privacy: An Enterprise Perspective on Risks and Complainace”,O'Reilly, USA,2011.
e-Reference:	
1	https://www.coursera.org/specializations/cloud-computing
2	https://onlinecourses.nptel.ac.in/noc21_cs62/preview
3	Optical Networks Tutorial (tutorialspoint.com)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Recommend suitable cloud delivery methods for an application.	U
CO2	Apply virtualization techniques to provide cloud service.	A
CO3	List and use different types of clouds based on the requirement.	R
CO4	Apply cloud security to the data using different levels of security and use cloud services like Google App Engine, Microsoft Azure and Amazon AWS	A

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		2		
CO2	2		2	1	3
CO3	3		2	2	2
CO4	2		2	2	3
Avg	2.25		2	1.25	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE31	WIRELESS AND MOBILE COMMUNICATION	Semester			II
PREREQUISITES		Category	PE	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning 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 SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to wireless communications - History and evolution – Mobile radio system around the world – Examples of common wireless communication systems - Trends in cellular radio and personal communications - Modern wireless communication systems: 2G Cellular networks – 3G wireless networks - 4G mobile web access - 5G faster wireless network - Wireless network standards

Unit II	**THE CELLULAR CONCEPT: SYSTEM DESIGN FUNDAMENTALS AND MODULATION TECHNIQUES FOR MOBILE RADIO**	**9**	**0**	**0**	**9**

Frequency reuse - Channel Assignment strategies - Handoff starategies - Interference and system capacity -Trunking and grade of service - Improving coverage and capacity in cellular systems - Modulation: Combined linear and Constant envelope modulation techniques - Spread Spectrum Modulation Techniques

Unit III	**MOBILE RADIO PROPAGATION: LARGE SCALE PATH LOSS**	**9**	**0**	**0**	**9**

Introduction to Radio wave propagation - Free-space propagation model- 3 basic propagation mechanisms and models : reflection - Ground reflection model – Diffraction - Knife-edge diffraction model -Scattering – radar cross section model - Practical Link budget design using path loss models - Outdoor propagation models - Indoor propagation models .

Unit IV	**MOBILE RADIO PROPAGATION: SMALL-SCALE FADING AND MULTIPATH FADING**	**9**	**0**	**0**	**9**

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 – statistical models for Multipath fading channels : 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 V	**EQUALISATION, DIVERSITY AND CHANNEL CODING**	**9**	**0**	**0**	**9**

Equalisation:Fundamentals – Training a generic adaptive equalizer – Equalizers in a communication receivers Survey of equalization - Linear equalizers - Nonlinear equalization - Algorithms for adaptive equalization –Fractionally spaced equalizers - Diversity: Practical Space Diversity Considerations - Polarization diversity -Frequency diversity -Time diversity - RAKE receiver - Coding: Turbo codes - Speech coding –Vocoders - LPC-Choosing Speech Codecs for Mobile communication - GSM codec - USDC codec.

Total (45 L) = 45 Periods

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.
e-Reference:	
1	http://www.pdfsdownload.com/download-pdf-for-free/wireless+communication+rappaport
2	https://www.oreilly.com/library/view/wireless-communications-principles/0130422320/
3	https://en.wikipedia.org/wiki/Adaptive_equalizer

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the difference in wireless compared to wired counterpart.	Understand
CO2	Understand the different propagation mechanisms and calculate large scale path loss.	Apply
CO3	Analyze small scale and multipath fading in mobile environment.	Apply
CO4	Analyze the cell structure and calculate interference and improve the coverage and capacity of cellular system.	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		1	2	1
CO2	2		1	2	1
CO3	2		1	2	1
CO4	2		1	2	1
Avg	2		1	2	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE32	PATTERN RECOGNITION AND MACHINE LEARNING	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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	0	9

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	0	9

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	0	9

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

Unit IV	INTRODUCTION TO Al AND PRODUCTION SYSTEMS	9	0	0	9

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	0	9

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 (45 L) = 45 Periods

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.
e-Reference:	
1	https://www.coursera.org/specializations/machine-learning-introduction
2	https://nptel.ac.in/courses/106106046
3	https://nptel.ac.in/courses/117108048

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Implement pattern classification methods and structural pattern recognition.	Understand
CO2	Implement feature extraction and selection.	Understand
CO3	Apply AI problem solving techniques for machine learning	Apply
CO4	Apply the concepts of various planning algorithm and expert systems.	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		2	2	2
CO2	2		2	2	2
CO3	3		3	3	3
CO4	2	2	2	2	2
Avg	2.25	0.5	2.25	2.25	2.25

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE33	VOICE AND DATA NETWORKS	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain the knowledge on computer networks and provides a good background for advanced studies in voice and data 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 network.

Unit I	INTRODUCTION TO VOICE AND DATA NETWORKS	9	0	0	9

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	0	9

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	0	9

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 DATAS NETWORK	9	0	0	9

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	0	9

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 (45 L) = 45 Periods

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	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
e-Reference:	
1	https://www.youtube.com/watch?v=Y4tOm5rdmtY
2	http://www.nptelvideos.in/2012/11/data-communication.html
3	https://www.digimat.in/nptel/courses/video/106105082/L32.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	To understand the introduction to voice and data networks.	U
CO2	To Analyse the transmission methods and switching.	A
CO3	To understand the concept of data link layer protocols and design delay models.	U
CO4	To Analyze the concept of interconnecting networks.	A

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	1	1
CO2	1	1	2	1	1
CO3	1	1	2	1	1
CO4	1	1	2	1	1
Avg	1	1	2	1	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE34	DIGITAL IMAGE AND VIDEO PROCESSING	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To study the image fundamentals and mathematical transforms necessary for image Processing.
2	To study the image enhancement techniques, To study image restoration procedures
3	To study the image compression procedures

Unit I	FUNDAMENTALS OF IMAGE PROCESSING AND IMAGE TRANSFORMS	9	0	0	9

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Applications of Digital image processing. Introduction, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform and its transforms, Importance of phase, Walsh transform, Hadamard transform, Haar transform, slant transform Discrete cosine transform, KL transform, singular value decomposition, Radon transform, comparison of different image transforms.

Unit II	IMAGE ENHANCEMENT	9	0	0	9

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering. Image Restoration: Introduction to Image restoration, Image degradation, Types of image blur, Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques.

Unit III	IMAGE SEGMENTATION	9	0	0	9

Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., Classification of segmentation techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on thresholding, Edge based segmentation, Edge detection and linking, Hough transform, Active contour.

Unit IV	IMAGE COMPRESSION	9	0	0	9

Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, Fundamentals of information theory, Run length coding, Shannon – Fano coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image compression standard, Wavelet-based image compression, JPEG Standards.

Unit V	2-D MOTION ESTIMATION	9	0	0	9

Optical flow, general methodologies, pixel-based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

Total (45 L) = 45 Periods

Text Books:	
1	Gonzaleze and Woods ,"Digital Image Processing ", 3rd edition , Pearson 2.
2	Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication ",1st edition , PHI
Reference Books:	
1	Digital Image Processing and Analysis-Human and Computer Vision Application with CVIP Tools – ScotteUmbaugh, 2nd Ed, CRC Press, 2011.
2	Digital Video Processing – M. Tekalp, Prentice Hall International
3	Digital Image Processing – S.Jayaraman, S.Esakkirajan, T.Veera Kumar – TMH, 2009
4	Multidimentional Signal, Image and Video Processing and Coding – John Woods, 2ndEd, Elsevier
e-Reference:	
1	http://ijariie.com/AdminUploadPdf/IMAGE_COMPRESSION_TECHNIQUES_ijariie1406_volume_1_15_page_100_105.pdf
2	https://telin.ugent.be/~sanja/ImageProcessingCourse/08c_VideoCompression.pdf
3	http://booksite.elsevier.com/samplechapters/9780123814203/Woods_11.2_through_11.3.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Study about the representation of digital images in transform domain, application of various image transforms.	Remember
CO2	Understand image degradation, image restoration techniques using spatial filters and frequency domain	Understand
CO3	Study about the detection of point, line and edges in images and redundancy in image compression techniques.	Remember
CO4	Understand the general methodologies for 2D motion estimation, various coding used in video processing.	Understand

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	1		2
CO2	1		2	1	
CO3	2	1		2	1
CO4	1		2		1
Avg	1.5	0.75	1.25	0.75	1
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COE41	SPREAD SPECTRUM COMMUNICATION	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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 performance analysis of spread spectrum systems.

Unit I	**SPREADING CODES**	**9**	**0**	**0**	**9**

Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of Shift Register 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**	**0**	**9**

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**	**0**	**9**

Baseband Recovery - Carrier Synchronization - Code Synchronization – Pseudo noise Acquisition in Direct Sequence Receivers- Pseudo noise Tracking in Direct Sequence Receivers.

Unit IV	**SPREAD SPECTRUM IN MULTIPATH ENVIRONMENT**	**9**	**0**	**0**	**9**

Spread Spectrum Communication System Model, Performance of Spread Spectrum Systems without Coding. Performance of Spread Spectrum Systems with Forward Error Correction: Elementary Block Coding Concepts-Optimum Decoding Rule-Calculation of Error Probability-Elementary Convolution Coding Concepts, - Decoding and Bit-Error Rate.

Unit V	**PERFORMANCE ANALYSIS OF SPREAD SPECTRUM SYSTEM**	9	0	0	3

Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrow band interferences Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver.

Total (45 L) = 45 Periods

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	Don Torrieri, "Principles of Spread-Spectrum Communication Systems", 3rd Edition
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	Robert C.Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994..
e-Reference:	
1	https://nptel.ac.in/courses/117105077/
2	http://www.rgcetpdy.ac.in/Notes/IT/III%20YEAR/COMMUNICATION%20ENGINEERING-II/Unit%202.pdf
3	https://www.tutorialspoint.com/digital_communication/digital_communication_spread_spectrum_modulation.htm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	To be able to arrive at detailed specifications of the spread spectrum systems.	Remember
CO2	To design systems based on spread spectrum synchronization.	Understand
CO3	To design the spread spectrum in multipath environment.	Apply
CO4	To Know the concept of Performance analysis of spread spectrum system.	Understand

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	1	2	1
CO2	1	2			1
CO3	2		2	1	2
CO4	1	2		2	
Avg	1.5	1.25	0.75	1.25	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE42	MIMO SYSTEMS	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To give comprehensive coverage of coding techniques for Multiple Input Multiple Output (MIMO) communication systems.
2	To analyze 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**	**0**	**9**

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**	**0**	**9**

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**	**0**	**9**

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**	**0**	**9**

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**	**0**	**9**

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

Total (45 L) = 45 Periods

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.
4	Huaibei Zhou” Advance MIMO systems” Scientific Research Publishing; 1st edition (1 September 2009).
e-Reference:	
1	https://nptel.ac.in/noc/individual_course.php?id=noc17-cs37
2	https://nptel.ac.in/courses/117104115/34
3	https://nptel.ac.in/noc/individual_course.php?id=noc16-ec11

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the diversity techniques and design the MIMO channels	U
CO2	Analyse the performance of for Space time Trellis code.	A
CO3	Design concatenated codes.	A
CO4	Understand Frequency selective channels to estimate the capacity of MIMO channels.	A

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	1	2
CO2	1	1	2	1	2
CO3	1	1	2	1	2
CO4	1	1	2	1	2
Avg	1	1	2	1	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE43	HIGH PERFORMANCE NETWORKS	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the high-speed computer network architectures, concepts of multimedia networking and current network management concepts
2	To study the recent network concepts with reference to MPLS and VPN.
3	To study about the mathematical models related to network performance analysis

Unit I	SWITCHING NETWORKS	9	0	0	9

Switching – Packet switching - Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched – SONET, DWDM, DSL, Intelligent Networks – CATV, ATM – Features, Addressing Signaling & Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.

Unit II	MULTIMEDIA NETWORKING APPLICATIONS	9	0	0	9

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP differentiated services.

Unit III	ADVANCED NETWORKS CONCEPTS	9	0	0	9

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networksP2P connections. -IPv4 vs. v6.

Unit IV	PACKET QUEUES AND DELAY ANALYSIS	9	0	0	9

Little's theorem, Birth and Death process, Queueing discipline- Control & stability -, Markovian FIFO Queueing system, Non-Markovian - Pollaczek-Khinchin Formula and M/G/1, M/D/1, self- similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.

Unit V	NETWORK MANAGEMENT & SNMP	9	0	0	9

Network Architecture, SNMP Basics, SNMP Naming and OIDs, MIBs, SNMPv1 Data Types, ASN.1 Syntax and SNMP, SNMP Tables, SNMP Operations, MIB Browsing, MIB-2, SNMP and ASN.1 Encoding

Total (45 L) = 45 Periods

Text Books:

1	J.F. Kurose & K.W. Ross, “Computer Networking- A Top Down Approach Featuring the Internet”, Pearson, 6th Edition, 2012.
2	Nader F.Mir, “Computer and Communication Networks”, Pearson Education, 2 nd Edition 2015.

Reference Books:

1	Peter Dordal , "An Introduction to Computer Networks" , Release 1.9.16, 2018.
2	Walrand .J. Varatya, “High Performance Communication Network”, Morgan Kaufmann publishers, 2 nd Edition, 2000.
3	Fred Halsall and Lingana Gouda Kulkarni, “Computer Networking and the Internet”, Fifth Edition, Pearson Education, 2012.
4	Jain Raj “High Performance TCP/IP Networking ”, Prentice-Hall of India Pvt.Ltd 2012
e-Reference:	
1	https://www.intel.com/content/www/us/en/collections/products/networking/high-performance-networking.html?s=Newest
2	https://link.springer.com/book/10.1007/978-0-387-35388-3
3	https://www.oreilly.com/library/view/high-performance-browser/9781449344757/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	To be able to design and implement network protocols in HPCN.	Understand and Analyse
CO2	To be able to design and implement protocols in multimedia networks	Understand and Analyse
CO3	To be able to compare the various methods of providing connection-oriented services and to services over an advanced network with reference to MPLS, VPN.	Understand
CO4	To be able to analyze performance of network related issues using mathematical models and explore the concepts of network management.	Analyse

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	2	2	2	2	2
CO4	2	2	2	2	2
Avg	2	2	2.5	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE44	5G COMMUNICATION NETWORKS		Semester			II
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To describe the evolution of mobile communication leading to the introduction of 5G
2	To identify the spectrum requirement
3	To explain the key innovations in radio and network

Unit I	INTRODUCTION TO 5G	9	0	0	9

3G and 4G(LTE) overview- Introduction to 5G – Use Cases - Evolving LTE to 5G Capability- 5G NR and 5G core network (5GCN) - 5G Standardization - 3GPP and IMT2020 - Spectrum for 5G – 5G deployment - Options, Challenges and Applications.

Unit II	5G WIRELESS PROPAGATION CHANNELS AND SPECTRUM	9	0	0	9

Channel modeling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems. Spectrum for 4G – Spectrum Challenges in 5G- 5G Spectrum technologies- Value of spectrum for 5G.

Unit III	TRANSMISSION AND DESIGN TECHNIQUES FOR 5G	9	0	0	9

Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), nonorthogonal multiple accesses (NOMA).

Unit IV	DEVICE-TO-DEVICE (D2D) COMMUNICATIONS	9	0	0	9

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multihop and multi-operator D2D communications.

Unit V	MILLIMETER WAVE COMMUNICATIONS	9	0	0	9

Millimeter-wave Communications – spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)

Total (45 L) = 45 Periods

Text Books:	
1	Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks" , Cambridge University Press
2	Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell
Reference Books:	
1	Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
2	Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
3	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
4	Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press.
e-Reference:	
1	https://nptel.ac.in/courses/112104181/
2	https://www.qualcomm.com
3	https://5glab.de

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Able to analyze the performance of different channel models adopted in 5G wireless Systems	Analyze
CO2	Able to design a transceiver for Multicarrier waveforms.	Understand
CO3	Able to analyze multiple access techniques in 5G networks	Analyze
CO4	Able to design a pilot, estimate channels and analyze capacity for single cell and multicell Massive MIMO and analyze different types of cooperative communications.	Analyze

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	1	2
CO2	2	1	2	1	2
CO3	2	1	3	2	2
CO4	2	1	3	2	2
Avg	2	1	2.75	1.5	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE51	DSP ARCHITECTURE	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Gain knowledge in various digital Signal Processor
2	provide in-depth knowledge on Third generation DSP Architecture and programming skills
3	provide in-depth knowledge on Advanced DSP architectures and its applications

Unit I	ARCHITECTURE OF PROGRAMMABLE DSPs	9	0	0	9

Multiplier and multiplier accumulator, modified bus structures and memory access in PDSPs, multiple access memory, multiport memory, SIMD, VLIW architectures, pipelining, special addressing modes in PDSPs, on-chip peripherals.

Unit II	TMS320C5X PROCESSOR	9	0	0	9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

Unit III	TMS320C6X PROCESSOR	9	0	0	9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

Unit IV	ADSP PROCESSORS	9	0	0	9

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

Unit V	ADVANCED PROCESSORS	9	0	0	9

Architecture of TMS320C54X: Pipe line operation, Code Composer studio –Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

Total (45 L) = 45 Periods

Text Books:

1	B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2	Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012

Reference Books:

1	Lapsley et al., DSP Processor Fundamentals, Architectures & Features‖, S. Chand & Co, 1 st Edition, 2000

2	Sen M. Kuo&WoonSergGan, Digital Signal Processors Architectures, Implementation and Application‖, Pearson Practice Hall, 1st Edition, 2013
3	Digital signal Processing-Jonatham stein, John Wiley,2005
4	Peter Pirsch, Architectures for Digital Signal Processing‖, John Weily, 1 st Edition, 2007.
e-Reference:	
1	https://nptel.ac.in/courses/108106149
2	https://nptel.ac.in/courses/108102045
3	https://youtube.com/playlist?list=PLMpCSwrw7iRG_78dNkxO76zezlEF81qIx

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Able to distinguish between the architectural features of General-purpose processors and DSP processors	Analyse
CO2	Understand the architectures of TMS320C5x,TMS320C6X and advanced processors	Understand
CO3	Acquire knowledge about architecture various addressing modes of ADSP processors	Understand
CO4	Design and implement basic DSP algorithms	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2			2	2
CO2	2			2	2
CO3	2			3	2
CO4	3			2	2
Avg	2.25			2.25	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE52	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	Semester			II
PREREQUISITES		**Category**	**PE**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To develop an understanding of basics of Electromagnetic interference in electronic systems
2	To acquire knowledge on the EMI coupling mechanisms and concepts of EMI control schemes
3	To get acquainted with design PCB incorporating EMC principles, current EMC standards and measurement techniques

Unit I	**EMI/EMC CONCEPTS**	**9**	**0**	**0**	**9**

EMI/EMC Concepts, EMI-EMC definitions and Units of parameters, Sources and victim of EMI Conducted and Radiated EMI Emission, Susceptibility, Transient EMI, ESD, Radiation Hazards.

Unit II	**EMI COUPLING PRINCIPLES**	**9**	**0**	**0**	**9**

EMI Coupling Principles - Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling ; Differential mode coupling ; Near field cable to cable coupling, cross talk ; Field to cable coupling ; Power mains and Power supply coupling. Simulation of Electromagnetic interference.

Unit III	**EMI CONTROL TECHNIQUES**	**9**	**0**	**0**	**9**

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control.

Unit IV	**EMC DESIGN OF PCBs**	**9**	**0**	**0**	**9**

EMC Design Of PCBs: Component selection and mounting; PCB trace impedance; Routing; Cross talk control; Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations; EM simulation of PCB's

Unit V	**EMI MEASUREMENT AND STANDARDS**	**9**	**0**	**0**	**9**

EMI Measurements: Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Receiver and spectrum analyzer; Civilian standards- CISPR, FCC, IEC, EN; Military standards: MIL461E/462.

Total (45 L) = 45 Periods

Text Books:

1	David A Weston," Electromagnetic Compatibility – Methods, Analysis, Circuits and measurements", CRC press, Bocaraton 2017
2	Tim Williams, "EMC for product Designers",5ed,Newness,2017.

Reference Books:

1	Patrick G. Andre and Kenneth Wyatt," EMI Troubleshooting Cookbook for Product Designers (Electromagnetics and Radar),SciTech publishing,2014
2	C.R.Paul, "Introduction to Electromagnetic Compatibility", 2nd ed John Wiley and Sons, Inc, 2010.
3	Henry W.Ott.," Electromagnetic Compatibility Engineering, Revised edition, Wiley Black well Newyork, 2009.
4	Printed Circuit Board Design Techniques for EMC Compliance: A Handbook for Designers, 2nd Edition Mark I. Montrose, ISBN: 978-0-780-35376-3 July 2000 Wiley-IEEE Press
e-Reference:	
1	https://www.mclpcb.com/blog/pcb-electromagnetic-issues/
2	https://www.electronics-notes.com/articles/analogue_circuits/emc-emi-electromagnetic-interference-compatibility/pcb-design-for-emc.php
3	https://www.newelectronics.co.uk/content/features/emc-basics-and-practical-pcb-design-tips

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand EMI and susceptibility	Understand
CO2	Identify EMI coupling mechanisms	Analyse
CO3	Use appropriate EMI control schemes in electronic systems	Understand
CO4	Design PCBs with EMC and Conduct EMI measurements according to standards	Design

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	1	2	2
CO2	2	1	1	2	2
CO3	2	2	2	2	2
CO4	2	2	2	2	2
Avg	2	1.5	1.5	2	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE53	RADAR SIGNAL PROCESSING	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn about the science behind the orbiting satellites and various multiplexing schemes
2	To impart knowledge on earth station parameters used for satellite communication.
3	To gain knowledge of navigation systems especially GPS in detail.

Unit I	RADAR BASICS	9	0	0	9

A Preview of Basic Radar Signal Processing, Radar Literature, Signal Models, components of a Radar Signal, Amplitude Models, clutter, Noise Model and Signal -to -Noise Ratio, Jamming, Frequency Models-The Doppler Shift, Spatial Models, Spectral Model.

Unit II	SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS	9	0	0	9

Domains and Criteria for Sampling Radar Signals, Sampling in the Fast Time Dimension, Sampling in Slow Time – Selecting the Pulse Repetition Interval, Sampling the Doppler Spectrum, Sampling in the Spatial and Angle Dimensions, Quantization, I/Q Imbalance and Digital I/Q

Unit III	DOPPLER PROCESSING	9	0	0	9

Alternate Forms of the Doppler Spectrum, Moving Target Indication (MTI), Pulse Doppler Processing, Pulse Pair Processing, Additional Doppler Processing Issues, Clutter Mapping and the Moving Target Detector, MTI for moving platforms.

Unit IV	SYNTHETIC APERTURE IMAGING	9	0	0	9

Introduction to Synthetic Aperture Imaging, Introduction to SAR Fundamentals, Strip map SAR Data Characteristics, Strip map SAR Image Formation Algorithms, Spotlight SAR Data Characteristics, the Polar Format Image Formation Algorithm for Spotlight SAR, Interferometric SAR.

Unit V	BEAMFORMING AND SPACE-TIME ADAPTIVE PROCESSING	9	0	0	9

Introduction to Beamforming and Space-Time Adaptive Processing- Spatial Filtering, Space-Time Signal Environment, Space-Time Signal Modelling, Processing the Space-Time Signal, Computational Issues in STAP, Reduce – Dimension STAP, Advanced STAP Algorithms and Analysis, Limitations to STAP

Total (45 L) = 45 Periods

Text Books:

1	Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw Hill
2	Fred E. Nathanson, “Radar Design Principles: Signal Processing and The Environment”, 2nd Edition, 1999, PHI.

Reference Books:

1	M.I. Skolnik, “Introduction to Radar Systems”, 3rd Edition, 2001, TMH.
2	Peyton Z. Peebles, Jr., “Radar Principles”, 2004, John Wiley.
3	R. Nitzberg, “Radar Signal Processing and Adaptive Systems”, 1999, Artech House.
4	F.E. Nathanson, “Radar Design Principles”, 1st Edition, 1969, McGraw Hill.
e-Reference:	
1	Radar: Introduction to Radar Systems — Online Course | MIT Lincoln Laboratory
2	Microsoft Word - semreport1.doc (iitb.ac.in)
3	Naren Naik Digital Signal Processing Course (iitk.ac.in)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the factors affecting the radar performance using radar range equation to calculate transmitter power	Understand
CO2	Analyze the principle of frequency modulated –continuous wave radar and apply it for altimeter applications	Analyze
CO3	Analyze the statistical parameters of radar cross section of targets to measure signal to noise ratio and system losses	Analyze
CO4	Analyze the detection techniques of target echo signal reflected back to the radar antenna for obtaining the location and distance of the reflecting object.	Analyze

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	1	2	2
CO2	2	1	1	2	2
CO3	3	1	2	2	2
CO4	2	1	2	2	2
Avg	2.25	1	1.5	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COE54	NATURAL LANGUAGE PROCESSING	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the representation and processing of Morphology and Part-of Speech, Taggers and to appreciate various techniques used for speech synthesis and recognition.
2	To understand different aspects of natural language syntax and the various methods used for processing syntax and disambiguating word senses.
3	To appreciate the various representations of semantics and discourse and to know about various applications of natural language processing.

Unit I	MORPHOLOGY AND PART-OF SPEECH PROCESSING	9	0	0	9

Introduction –Regular Expressions and Automata- Non-Deterministic FSAs.Tranducers – English Morphology – Finite-State Morphological Parsing - Porter Stemmer – Tokenization-Detection and Correction of Spelling Errors. N-grams – Perplexity - Smoothing - Interpolation - Backoff Part-of Speech Tagging – English Word Classes - Tagsets - Rule-Based - HMM - Transformation-Based Tagging - Evaluation and Error Analysis. Hidden Markov and Maximum Entropy Models

Unit II	SPEECH PROCESSING	9	0	0	9

Phonetics – Articulatory Phonetics - Phonological Categories - Acoustic Phonetics and Signals -Speech Synthesis – Text Normalization – Phonetic and Acoustic Analysis – Diphone Waveform synthesis – Evaluation- Automatic Speech Recognition –Architecture – Hidden Markov Model to Speech - MFCC vectors - Acoustic Likelihood Computation - Evaluation. Triphones – Discriminative Training - Modelling Variation. Computational Phonology- Finite-State Phonology – Computational Optimality Theory - Syllabification - Learning Phonology and Morphology

Unit III	SYNTAX ANALYSIS	9	0	0	9

Formal Grammars of English – Constituency - Context-Free Grammars –Grammar Rules – Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars. Syntactic Parsing – Parsing as Search - Ambiguity - Dynamic Programming Parsing Methods –CKY-Earley and Chart Parsing- Partial Parsing-Evaluation. Statistical Parsing – Probabilistic Context-Free Grammars – Probabilistic CKY Parsing of PCFGs –Probabilistic Lexicalized CFGs – Collins Parser Language and Complexity -The Chomsky Hierarchy -The Pumping Lemma

Unit IV	SEMANTIC AND PRAGMATIC INTERPRETATION	9	0	0	9

Representation of Meaning – Desirable Properties - Computational Semantics -Word Senses - Relations Between Senses – WorldNet - Event Participants- Proposition Bank - Frame Net – Metaphor. Computational Lexical Semantics – Word Sense Disambiguation- Supervised Word Sense Disambiguation - Dictionary and Thesaurus Methods- Word Similarity – Minimally Supervised WSD - Hyponymy and Other Word Relations - Semantic Role Labelling – Unsupervised Sense Disambiguation. Computational Discourse - Discourse Segmentation – Unsupervised Discourse - Segmentation - Text Coherence - Reference Resolution –Phenomena– Features and algorithms - Pronominal Anaphora Resolution

Unit V	APPLICATIONS	9	0	0	9

Information Extraction – Named Entity Recognition - Relation Detection and Classification – Temporal and Event Processing - Template-Filling - Biomedical Information Extraction. Question Answering and Summarization - Information Retrieval -Factoid Question Answering - Summarization - Single and Multi-Document Summarization - Focused Summarization - Evaluation. Dialog and Conversational Agents – Properties of Human Conversations – Basic Dialogue Systems - VoiceXML - Information- State and Dialogue Acts - Markov Decision Process Architecture. Machine Translation –Issues in Machine Translation - Classical MT and the Vauquois Triangle - Statistical MT - Phrase-Based Translation Model - Alignment in MT –IBM Models – Evaluation
Total (45 L) = 45 Periods

Text Books:	
1	Jurafsky and Martin, "Speech and Language Processing", Pearson Prentice Hall, Second Edition, 2008.
2	Christopher D. Manning and HinrichSchütze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
Reference Books:	
1	Stevan Bird, "Natural Language Processing with Python", Shroff, 2009.
2	James Allen, "Natural Language Understanding", Addison Wesley, Second Edition, 2007.
3	NitinIndurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", Second Edition, 2010.
4	Alexander Clark, Chris Fox, Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley-Blackwell, 2012.
e-Reference:	
1	https://www.ibm.com/cloud/learn/natural-language-processing
2	https://www.techtarget.com/searchenterpriseai/definition/natural-language-processing-NLP
3	https://www.sas.com/en_us/insights/analytics/what-is-natural-language-processing-nlp.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Identify the different linguistic components of given sentences.	Understand
CO2	Design a morphological analyser for a language of your choice using finite state automata concepts.	Design
CO3	Implement the Earley algorithm for a language of choice by providing suitable grammar and words.	Analyse
CO4	Use a machine learning algorithm for word sense disambiguation and Build a tagger to semantically tag words using WordNet and Design a business application	Design

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	2	2	2
CO2	2	2	2	2	2
CO3	2	1	2	2	2
CO4	2	2	1	2	2
Avg	2	1.5	1.75	2	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COE61	COGNITIVE RADIO	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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 analyse the spectrum management functions using cognitive radio systems and cognitive radio networks.

Unit I	**INTRODUCTION TO COGNITIVE RADIOS**	**9**	**0**	**0**	**9**

Marking radio self-aware, the cognition cycle, organization of congnition tasks, structuring knowledge for cognition tasks, Enabling location and environment awareness in cognitive radios –concepts, architecture, design considerations.

Unit II	**SDR ARCHITECTURE**	**9**	**0**	**0**	**9**

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	**COGNITIVE RADIO ARCHITECTURE**	**9**	**0**	**0**	**9**

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

Unit IV	**COGNITIVE RADIO NETWORK SECURITY**	**9**	**0**	**0**	**9**

Overview of IEEE 802.22 standard for broadband wireless access in TV bands -Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V	**MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO**	**9**	**0**	**0**	**9**

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Total (45 L) = 45 Periods

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.
e-Reference:	
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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts and design of cognitive radios.	Understand
CO2	Study about the SDR architecture and analysis.	Remember
CO3	Analyse the various cognitive radio network architectures and network security.	Analyze
CO4	To analyse the performance of MAC and network layer design for cognitive radio .	Apply
CO5		

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	2	1	2
CO2		2	1		1
CO3	2	1		2	
CO4	2		1	2	1
Avg	1.25	1.25	1	1.25	1

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE62	INTERNET OF THINGS	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To assess the vision and introduction of IoT and to Implement Data and Knowledge Management and use of Devices in IoT Technology.
2	To Understand State of the Art - IoT Architecture and to build a small low-cost embedded system using Single Board Computers
3	To learn the various case study of IoT systems.

Unit I	INTRODUCTION AND APPLICATIONS	9	0	0	9

Introduction to IoT – Definition, Characteristics, functional requirements, motivation, Physical design - things in IoT, IoT protocols, Logical Design - functional blocks, communication models, Communication APIs, Applications – Home Automation, Cities, Environment, Energy, Agriculture, Health, Industry

Unit II	IoT DESIGN & SYSTEM MANAGEMENT	9	0	0	9

IoT &M2M – Machine to Machine, Difference between IoT & M2M, Software Defined Network, Network function virtualization, IoT system management – SNMP, NETCONF, YANG, IoT Design methodology.

Unit III	IoT PROTOCOLS & SYSTEM	9	0	0	9

Protocols – HTTP, UPnP, CoAP, MQTT, XMPP. IoT systems logical design using python - python data types & data structures, control flow, functions or modules. Modules & package of python, python packages of interest for IoT-JSON, XML, HTTP & URL Lib, SMTP Lib. Exemplary Device: Raspberry Pi - Linux on Raspberry Pi – Programming Raspberry Pi with Python.

Unit IV	IoT CLOUD & DATA ANALYTICS	9	0	0	9

Introduction to Cloud storage Models – WAMP – Xively Cloud for IoT – Python Web Application Framework-Django – Designing a RESTful based Web API. Data Analytics for IoT – Apache Hadoop, Apache Oozie.

Unit V	IoT SECURITY	9	0	0	9

IoT attacks - Phase attacks, Attacks as per architecture, Attacks based on components. Security Protocols - Time-Based Secure Key Generation and Renewal - Security access algorithms for unidirectional data transmissions, Security access algorithms for bidirectional data transmissions.

Total (45 L) = 45 Periods

Text Books:

1	Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hand on approach", Universities Press (India) Private Limited, 2014
2	Pethuru Raj, Anupama C. Raman, "The Internet of Things – Enabling Technologies, Platforms and Use cases" , CRC Press, Taylor & Francis Group, 2017.

Reference Books:	
1	William Stallings, Lawrie Brown, "Computer Security: Principles and Practice", Third Edition, Pearson, 2014.
2	Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations," 1st edition, CRC Press, 2016.
3	Rajkumar Buyya, "Internet of Things – Principles and Paradigms" , Published by Morgan Kaufmann, Elsevier, 2016.
4	Introduction to IoT Paperback – 31 January 2022 by Sudip Misra , Anandarup Mukherjee, Arijit Roy Cambridge University Press
e-Reference:	
1	https://www.oracle.com/in/internet-of-things/what-is-iot/
2	https://www.networkworld.com/article/3207535/what-is-iot-the-internet-of-things-explained.html
3	https://aws.amazon.com/what-is/iot/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concepts and design of cognitive radios.	Understand
CO2	Study about the SDR architecture and analysis.	Remember
CO3	Analyse the various cognitive radio network architectures and network security.	Analyse
CO4	To analyse the performance of MAC and network layer design for cognitive radio.	Analyse

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	2	1	2
CO2	1	2	1	1	2
CO3	2	2	2	1	1
CO4	2	2	2	2	1
Avg	1.5	2	1.75	1.25	1.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE63	VLSI FOR WIRELESS COMMUNICATION	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

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

Unit I	WIRELESS COMMUNICATION CONCEPTS	9	0	0	9

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	0	9

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	0	9

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	0	9

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	0	9

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

Total (45 L) = 45 Periods

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.
e-Reference:	
1	https://nptel.ac.in/courses/117104099/
2	http://www.nptelvideos.in/2012/12/wireless-communication.html
3	http://videos.gitam.edu/nptel/ece.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the fading concepts	U
CO2	Design Low Noise amplifier and Mixers.	A
CO3	Evaluate the performance of Frequency synthesizers.	A
CO4	Design and analyze Power amplifiers.	A

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	1	2
CO2	1	1	2	1	2
CO3	1	1	2	1	2
CO4	1	1	2	1	2
Avg	1	1	2	1	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE64	CRYPTOGRAPHY AND NETWORK SECURITY	Semester			III
PREREQUISITES		Category	PE	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand· the importance and goals of communication network and information security and introduce them to the different types of attacks.
2	To expose different approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.
3	To· appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.

Unit I	**INTRODUCTION ON SECURITY**	**9**	**0**	**0**	**9**

Security Goals, Cryptographic attacks, Security services and mechanisms Techniques: Cryptography and Steganography, Traditional Symmetric-Key Ciphers: Substitution Ciphers and Transposition Ciphers, Mathematics for Cryptography.

Unit II	**SYMMETRIC AND ASYMMETRIC KEY ALGORITHMS**	**9**	**0**	**0**	**9**

Introduction to Block Ciphers and Stream Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, Principle of asymmetric key algorithms, RSA Cryptosystem.

Unit III	**INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT**	**9**	**0**	**0**	**9**

Message Integrity, Hash functions: SHA 512, Whirlpool, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

Unit IV	**NETWORK SECURITY, FIREWALLS AND WEB SECURITY**	**9**	**0**	**0**	**9**

Introduction on Firewalls, Types of Firewalls, IP Security, E-mail security: PGP- S/MIME, Web security: SSL-TLS, SET.

Unit V	**WIRELESS NETWORK SECURITY**	**9**	**0**	**0**	**9**

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. Security for WLAN, Security for Broadband networks: Security challenges in 4G and 5G deployments, Introduction to side channel attacks and their counter measures.

Total (45 L) = 45 Periods

Text Books:

1	Behrouz A. Forouzan ,"Cryptography and Network security", 3e, McGraw- Hill, 2015
2	William Stallings, "Cryptography and Network security: principles and practice", Prentice Hall of India, New Delhi, 7th Edition,2017

Reference Books:

1	Atul Kahate, "Cryptography and Network security", Tata McGraw-Hill, 4th Edition, 2019.
2	R.K.Nichols and P.C. Lekkas ,"Wireless Security: Models , threats and Solutions", McGraw- Hill, 2001.

3	S.Bose, P.Vijayakumar, “Cryptography and Network security”, Pearson, 2017.
4	S.Musa, “Network Security and Cryptography”, Mercury Learning and Information LLC, 2018.
e-Reference:	
1	"Security of Wireless Ad Hoc Networks," http://www.cs.umd.edu/~aram/wireless/survey.pdf
2	Introduction to side channel attacks – http://gauss.ececs.uc.edu/Courses/c653/lectures/SideC/intro.pdf.
3	https://nptel.ac.in/courses/106105162

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Demonstrate an understanding of the ways in which communication network security may get compromised and the basic principles of security algorithm design.	Understand
CO2	Familiar with the different types of security attacks, approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.	Remember
CO3	Implement and analyse the different algorithms and compare their performances.	Analyze
CO4	Appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1		1	1	1
CO2	2		2	2	2
CO3	3	1	2	3	2
CO4	2	1	2	2	2
Avg	2	0.5	1.75	2	1.75
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

22COE71	REMOTE SENSING	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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**	**0**	**9**

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, Multispectral, thermal and hyperspectral sensing, Remote sensing satellites and their features.

Unit II	**IMAGE PROCESSING SYSTEM AND DISPLAY**	**9**	**0**	**0**	**9**

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**	**0**	**9**

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

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

Image Classification, Supervised Classification, The Classification Stage, The Training Stage, Unsupervised Classification, Hybrid Classification, 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 integration.

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

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 Applications.

Total (45 L) = 45 Periods

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
Reference Books:	
1	Gonzalez Rafael C and Woods Richard E, "Digital Image Processing", 4th Ed., Pearson, 2018.
2	Richards John A & Xiuping Xia, "Remote Sensing Digital Image Analysis: An Introduction", Springer-Verlag, 2013
3	Robert Grier Reeves, "Manual of Remote Sensing", American Society of Photogrammetry , 2007.
4	Samantha Lavender, Andrew Lavender, "Practical handbook of remote sensing", CRC Press, 2017.
e-Reference:	
1	https://oceanservice.noaa.gov/facts/remotesensing.html
2	https://gisgeography.com/remote-sensing-earth-observation-guide/
3	https://nptel.ac.in/courses/105103193

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the basics of remote sensing systems.	Understand
CO2	Apply image processing techniques in the area of remote sensing.	Apply
CO3	Extract and analyse thematic information using image analysis techniques	Apply
CO4	Implement various remote sensing applications using the learnt technique.	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1		1	1	1
CO2	2		2	1	1
CO3	2	1	2	2	2
CO4	2	1	2	2	2
Avg	1.75	0.5	1.75	1.5	1.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE72	WAVELET SIGNAL PROCESSING	Semester	
PREREQUISITES	Category	Credit	

	L	T	P	TH
Hours/Week				

Course Learning 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	0	9

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

Unit II	WAVELET TRANSFORM	9	0	0	9

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 III	WAVELET PACKETS	9	0	0	9

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	0	9

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	0	9

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

Total (45 L) = 45 Periods

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	.Fundamentals of Wavelets: Theory, Algorithms, and Applications, J.C. Goswami and A.K. Chan, 2nd ed., Wiley, 2011
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	K. P. Soman, K. I. Ramachandran, “Insight into Wavelets: From Theory to Practice”, Third Edition, PHI, 2004.
e-Reference:	
1	https://web.stanford.edu/class/energy281/WaveletAnalysis.pdf
2	https://nptel.ac.in/courses/117101123
3	https://nptel.ac.in/courses/108101093

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform.	Understand
CO2	Understand wavelet basis and characterize continuous and discrete wavelet transforms	Understand
CO3	Understand multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties	Apply
CO4	Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.	Analyse

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1			1	1
CO2	1			1	1
CO3	2			2	2
CO4	2			2	2
Avg	1.5			1.5	1.5

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE73	BIO MEMS	Semester			II
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning 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	0	9

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	0	9

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

Unit III	SENSOR PRINCIPLES and MICRO SENSORS	9	0	0	9

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	0	9

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

Unit V	MICRO TOTAL ANALYSIS	9	0	0	9

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 (45 L) = 45 Periods

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

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the MEMS fabrication processes and characteristics of various materials.	Understand
CO2	Specify the design issues related to different types of sensors and actuators at micro scale level.	Remember
CO3	Understand the methods of actuation of fluids at micro level.	Understand
CO4	Learn the principles of Micro Actuators and Drug Delivery system and applications of Micro Total Analysis and Apply various procedures for the design of MEMS devices for healthcare applications	Apply

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	3	2
CO2	1	1	3	3	2
CO3	1	1	2	3	2
CO4	2	1	2	3	2
Avg	1.5	1	2.5	3	2

3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)

22COE74	BIG DATA TECHNOLOGIES	Semester			III
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain insights on big data analytics
2	To use Hadoop on suitable real time applications and explore Cassandra, Hive and Pig
3	To perform Map, Reduce and solve a real time problem involving databases like MongoDB

Unit I	INTRODUCTION	9	0	0	9

Types of Digital Data – Introduction to Big Data - Big Data Analytics - classification of Analytics - Greatest Challenges that Prevent Businesses from Capitalizing on Big Data - Top Challenges Facing Big Data - Why is Big Data Analytics Important? - Data Science - Terminologies Used in Big Data Environment - Few Top Analytics Tools.

Unit II	HADOOP	9	0	0	9

The big data technology landscape – NoSQL – Hadoop - Introduction to Hadoop - RDBMS versus Hadoop - RDBMS versus Hadoop - Hadoop Overview - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Application with Hadoop YARN - Hadoop Ecosystem

Unit III	**MAP REDUCE &** MONGODB	9	0	0	9

Introduction to Map reduce Programming- Introduction to MongoDB - What is MongoDB? - Why MongoDB? - RDBMS and MongoDB - Data Types in MongoDB – MongoDB Query Language

Unit IV	CASSANDRA AND HIVE	9	0	0	9

Introduction to Cassandra - Features of Cassandra - CQL Data Types – CQLSH – Key spaces - CRUD – llections – Alter - Import and Export – querying system tables Hive Architecture - Hive Data Types - Hive File Format - Hive Query Language- RC File Implementation – SerDe – User Defined Functions

Unit V	PIG AND CASE STUDIES	9	0	0	9

Introduction to Pig - The Anatomy of Pig - Pig on Hadoop - Pig Latin Overview - Data Types - Running Pig - Execution Modes of Pig - HDFS Commands - Relational operators - Eval Function - Complex Data Type - User Defined Function - parameter Substitution - Diagnostic Operator - Word Count Example - When to use Pig? - When NOT to use Pig? - Pig versus Hive - Reporting tool – Trends – Case studies: Walmart: How Big Data is used to drive supermarket performance –Netflix: How Netflix used Big Data to give us the programmes we want.

Total (45 L) = 45 Periods

Text Books:

1	Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publication, first edition. Reprint in 2016.
2	Bernard Marr, “Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results”, Wiley Publication, First edition, 2016.

Reference Books:	
1	DT Editorial Services, “Black Book- Big Data (Covers Hadoop 2, MapReduce, Hive, Yarn, PIG, R, Data visualization)”, Dream tech Press edition 2016.
2	Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications, First Edition 2016 .
3	Nathan Marz,James Warren, Big Data: Principles and best practices of scalable realtime data systems 1st Edition, Manning
4	Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press.
e-Reference:	
1	https://www.coursera.org/learn/big-data-emerging-technologies
2	https://onlinecourses.nptel.ac.in/noc21_cs86/preview
3	(339) Big Data & Hadoop Full Course - Learn Hadoop In 10 Hours | Hadoop Tutorial For Beginners | Edureka - YouTube

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Describe Big Data Analytics	R
CO2	Practically implement Hadoop on suitable real time applications with MONGODB	A
CO3	Perform Map Reduce and solve a real time problem using Cassandra, Hive or Pig	A
CO4	Understand how Big Data is used in real world to solve problems	U

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2		2		2
CO2	2		2	1	2
CO3	2		2		2
CO4	2	2	2	1	2
Avg	2	0.5	2	0.5	2
3/2/1 - indicates strength of correlation (3-High,2- Medium,1- Low)					

AUDIT COURSE

22AC01	ENGLISH FOR RESEARCH PAPER WRITING		SEMESTER I/II			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			2	**0**	**0**	**2**

COURSE OBJECTIVES:					
1.	To help the learners to realize the necessity of English in writing a Research paper				
2.	To enable the learners to write different sections of a research paper				
3.	To train the learners to become better writers of research papers				
UNIT I		**6**	**0**	**0**	**6**
Research paper and its importance, Structure of a research paper, Planning and preparation.					
UNIT II		**6**	**0**	**0**	**6**
English in research papers, Basic word order, Collocation, Being concise, Redundancy, Common errors.					
UNIT III		**6**	**0**	**0**	**6**
Key factors that determine the style of a paper, Journal's background, Passive form, Right tense forms, Cohesion and coherence.					
UNIT IV		**6**	**0**	**0**	**6**
Hedging and criticizing, Paraphrasing, Plagiarism, Ensuring quality of the paper and Useful phrases.					
UNIT V		**6**	**0**	**0**	**6**
Key skills in writing Title, Abstract, Introduction, Review of Literature, Discussion and Conclusion, Highlighting findings.					
Total(30L) = 30 Periods					

REFERENCE BOOKS:	
1	Adrian Wallwork, "English for Writing Research Papers," Springer New York Dorecht Heidelberg London, 2016
2	Howe, Stephen. "Phrase Book for Writing papers and Research in English," Cambridge University Press, 2012.
3	Goldbort R. "Writing for Science," Yale University press, 2006.
4	Gabor L Lovei. "Writing and Publishing Scientific Paper," Open Book Publishers, 2021

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	understand and appreciate the role of English in writing a good research paper	Understand
CO2	apply their knowledge in writing a research paper	Apply
CO3	analyze and assess the quality of their research paper	Analysis

22AC02	DISASTER MANAGEMENT				SEMESTER I/II
PREREQUISITES	CATEGORY	PE	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.

UNIT I	INTRODUCTION	4	0	0	4

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Disaster Prone Areas in India: Study of Seismic Zones; Area Prone to floods and droughts, Landslides and avalanches; Areas prone to cyclonic and coastal hazards with special reference to Tsunami; Post- Disaster diseases and epidemics.

UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	4	0	0	4

Economic Damage, Loss of Human And Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease And Epidemics, War And Conflicts.

UNIT III	DISASTER PREPAREDNESS AND MANAGEMENT	4	0	0	4

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT IV	RISK ASSESSMENT	4	0	0	4

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT V	DISASTER MITIGATION	4	0	0	4

Meaning, Concept And Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation In India.

Total(20L)= 20 Periods

REFERENCE BOOKS:

1	R. Nishith, Singh AK 2012 Disaster Management in India:Perspectives, issues and strategies New Royal Book Company, Lucknow
2	Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences And Reflections. Prentice Hall Of India, New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.	Understand
CO2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.	Evaluate
CO3	develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations	Create
CO4	Critically understand the strengths and weaknesses of disaster management approaches.	Understand

22AC03	SANSKRIT FOR TECHNICAL KNOWLEDGE			SEMESTER I/II		
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			2	**0**	**0**	**2**
COURSE OBJECTIVES						
To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.						
UNIT I	**ALPHABETS**		**8**	**0**	**0**	**8**
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences.						
UNIT II	**LITERATURE**		**8**	**0**	**0**	**8**
Order –Introduction of roots –Technical information about Sanskrit Literature						
UNIT III	**CONCEPTS**		**8**	**0**	**0**	**8**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics						
						Total(24L)= 24 Periods

REFERENCE BOOKS:	
1	" Abhyasa Pustakam"- Dr.Vishwas, Samskrita- Bharati Publication,New Delhi
2	"Tech Yourself Sanskrit" PrathamaDeeksha-Vempatikutumbshastri,Rashtriya Sanskrit Sansthan,New Delhi Publication
3	India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understanding basic Sanskrit language	Understand
CO2	Ancient Sanskrit literature about science & technology can be understood	Remembering
CO3	Being a logical language will help to develop logic in students	Apply

22AC04	VALUE EDUCATION				SEMESTER I/II
PREREQUISITES		CATEGORY	PE	Credit	0
		Hours/Week	L	T	P	TH
			2	0	0	2

COURSE OBJECTIVES

To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.

UNIT I	BASIC VALUES	4	0	0	4

Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moral valuation-Standards and principles-Value judgements.

UNIT II	CONFIDENCE	6	0	0	6

Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-Cleanlines-Honesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.

UNIT III	PERSONALITY DEVELOPMENT	6	0	0	6

Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - Universal brotherhood and religious tolerance –True friendship –Happiness Vs suffering –love for truth – Aware of self destructive habits- Association and Cooperation –Doing best for saving nature.

UNIT IV	LOVE AND COMPASSION	6	0	0	6

Character and Competence –Holy books vs Blind faith –Self –management and Good health – Science of reincarnation –Equality – Nonviolence –Humility -Role of Women –All religions and same message –Mind your Mind –Self -control –Honesty –Studying effectively.

Total(22L)= 22 Periods

REFERENCE BOOKS:

1. Chakraborty, S.K. “Values and Ethics for Organization Theory and Practice”, Oxford University Press, New Delhi, 1998.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Knowledge of self-development	Understand
CO2	Learn the importance of Human values	Remembering
CO3	Developing the overall personality	Create

22AC05	CONSTITUTION OF INDIA				SEMESTER I/II			
PREREQUISITES		CATEGORY	PE		Credit			0
		Hours/Week	L		T	P		TH
			2		0	0		2

COURSE OBJECTIVES

Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I	**HISTORY OF MAKING OF INDIAN CONSTITUTION**	**4**	**0**	**0**	**4**
History, Drafting Committee (Composition & working)					
UNIT II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**4**	**0**	**0**	**4**
Preamble, Salient Features.					
UNIT III	**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**	**4**	**0**	**0**	**4**
Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.					
UNIT IV	**ORGANS OF GOVERNANCE**	**4**	**0**	**0**	**4**
Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.					
UNIT V	**LOCAL ADMINISTRATION**	**4**	**0**	**0**	**4**
Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.					
UNIT VI	**ELECTION COMMISSION**	**4**	**0**	**0**	**4**
Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.					

Total(24L)= 24 Periods

REFERENCE BOOKS:

1	The Constitution of India, 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.
4	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics	Understand
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	Understand
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution	Understand
CO4	Discuss the passage of the Hindu Code Bill of 1956.	Understand

22AC06	PEDAGOGY STUDIES				SEMESTER I/II
PREREQUISITES		CATEGORY	PE	Credit	0
		Hours/Week	L	T	P	TH
			2	0	0	2

COURSE OBJECTIVES

To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. Identify critical evidence gaps to guide the development.

UNIT I		4	0	0	4

Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching

UNIT II		2	0	0	2

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

UNIT III		4	0	0	4

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV		4	0	0	4

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

UNIT V		2	0	0	2

Research gaps and future directions, Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact

Total(16L)= 16 Periods

REFERENCE BOOKS:

1	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) 361-379.
3	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.
5	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?	Create
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?	Understand
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	Remembering

22AC07	STRESS MANAGEMENT BY YOGA				SEMESTER I/II			
PREREQUISITES		CATEGORY	PE		Credit		0	
		Hours/Week	L	T	P	TH		
			2	0	0	2		

COURSE OBJECTIVES

To create a healthy, strong willed and intelligent young society through yoga practices.

UNIT I	**PHYSICAL AND MENTAL HEALTH**	**4**	**0**	**0**	**4**

Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing.

UNIT II	**REJUVENATION OF LIFE FORCE AND WILL POWER**	**4**	**0**	**0**	**4**

Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power

UNIT III	**DEVELOPMENT OF VIRTUES**	**4**	**0**	**0**	**4**

Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger.

UNIT IV	**STREAM LINING OF MIND**	**4**	**0**	**0**	**4**

Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties

UNIT V	**CAUSE AND EFFECT SYSTEM**	**4**	**0**	**0**	**4**

Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace

Total(24L)= 24 Periods

REFERENCE BOOKS:

1	"Thirukkural" , Pearls of Inspiration, Translation by Rajaram, Publisher :RUPA
2	"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited.
3	"Yoga for Humane Excellence" , Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	maintain good Physical health	Apply
CO2	develop will power	Create
CO3	take quick and right decisions	Evaluate
CO4	maintain good relationship with everyone around them his creating a Health Society	Apply

22AC08	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit	0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

To learn to achieve the highest goal happily, To become a person with stable mind, pleasing personality and determination, To awaken wisdom in students.

UNIT I		8	0	0	8

Neetisatakam – Holistics development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)
Verses-52,53,59(dont"s)
Verses71,73,75,78(do''s)

UNIT II		8	0	0	8

Approach to day to day work and duties.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 41, 47, 48,
Chapter 3-Verses 13, 21, 27, 35,
Chapter 6-Verses 5,13,17,23,35,
Chapter 18-Verses 45, 46, 48

UNIT III		8	0	0	8

Statement of basic knowledge.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 56, 62, 68,
Chapter 12-Verses 13, 14, 15, 16, 17, 18
Personality of Role model.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 17,
Chapter 3-Verses 36, 37, 42,
Chapter 4-Verses 18, 38, 42,
Chapter 18-Verses 37, 38, 63

Total(24L)= 24 Periods

REFERENCE BOOKS:

1	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2	Bhartrihari's Three Sataskam (Niti- Sringar – Vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve The highest goal in life	Understand
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity	Remembering
CO3	Study of Neetishatakam will help in developing versatile personality of students.	Understand