

BE ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER - VII

19L701 MICROWAVE ENGINEERING

3 0 0 3

INTRODUCTION : Microwave frequencies - Microwave systems - High frequency limitations of conventional tubes- Two cavity Klystron and Reflex klystron - Magnetron oscillator- Microwave solid devices: Microwave Transistors - Gunn diode oscillators-microwave network analysis-Scattering matrix. (9)

THEORY AND DESIGN OF FERRIMAGNETIC COMPONENTS : Basic properties of ferrite material - Plane wave propagation in Ferrite medium - Ferrite based isolator-Phase Shifters-Circulator - S-matrix representation – Active Microwave Circuits: Detectors and Mixers (9)

MICROWAVE PASSIVE COMPONENTS : Microwave Resonators, Series and Parallel Resonant Circuits - Transmission Line Resonators - Power Dividers and Directional Couplers, Properties, T-Junction Power Divider, Quadrature Hybrid Couplers. - Microwave Filters-Design by the Insertion Loss Methods- Transforms- Implementation. (12)

DESIGN OF MICROWAVE AMPLIFIERS AND OSCILLATORS : Characteristics of RF Transistors- Gain and Stability - Single- Stage Transistor Amplifier Design - Oscillator Design (6)

MICROWAVE COMMUNICATION SYSTEMS : Simplified microwave system - need for diversity-frequency and space diversity-Microwave radio stations-system gain. - Microwave radio stations-system gain (9)

Total L: 45

TEXT BOOKS:

1. David M Pozar , "Microwave Engineering", Fourth Edition, John Wiley and Sons, 2012.
2. Tomasi W , "Advanced Electronics communication System", Sixth Edition, Prentice Hall Inc, New Delhi, 2014.

REFERENCES:

1. Reinhold Ludwig , Pavel Bretchko , "RF Circuit Design", Asia Publication, 2011.
2. Collin R E , "Foundations of Microwave Engineering", John Wiley and Sons Inc., 2011.
3. Tomasi W , "Advanced Electronics communication System", Prentice Hall Inc, 2005.
4. Liao Y.S. , "Microwave devices and circuits", New Delhi, 2008, .

19L702 WIRELESS COMMUNICATION

3 0 0 3

INTRODUCTION: Introduction to wireless communication systems - Cellular concept- system design fundamentals Handoff Strategies- Interference and system capacity, Improving Coverage and Capacity (9)

WIRELESS CHANNEL MODELING : Free space propagation model, Reflection- Diffraction – Scattering - Log-normal shadowing. Small-scale multipath propagation, Types of small scale fading, Rayleigh and Ricean distribution, Input /output model of the wireless channel - Time and frequency coherence - Statistical channel models (9)

MULTIPLE ACCESS SCHEMES AND DIVERSITY : FDMA, TDMA, CDMA, SDMA and CSMA, OFDMA. Diversity Techniques – Frequency diversity, Time diversity, Code diversity, Antenna diversity –RAKE Receiver - SIMO, MISO, MIMO, MIMO-OFDM Technique (9)

CAPACITY OF WIRELESS CHANNELS : AWGN channel capacity – capacity of flat fading channels , Frequency- selective fading channels, Multiuser capacity, Downlink channel capacity, Uplink channel capacity, Outage capacity (9)

EVOLUTION OF WIRELESS TECHNOLOGIES : Mobile Technologies - GSM, 3G, 4G (LTE) and 5G technologies, Wireless LAN Technologies and WLL (9)

Total L: 45

TEXT BOOKS:

1. Andrea Goldsmith , "Wireless Communications", Cambridge University Press, 2012.
2. David Tse, Pramod Viswanath , "Fundamentals of Wireless Communication", Cambridge University Press, 2015.

REFERENCES:

1. Kamil Feher , "Wireless Digital Communications, Modulation & Spread Spectrum Applications", PHI, 2015.
2. William C. Y. Lee , "Mobile Communication Engineering", McGraw Hill, 2014.
3. Theodore S. Rappaport , "Wireless Communications", Pearson Education, 2017.
4. Andreas F. Molisch , "Wireless Communications", Wiley, 2011.

19L711 MICROWAVE ENGINEERING LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS :

- 1) Study of Klystron oscillator characteristics.
- 2) Study of GUNN diode characteristics
- 3) Determination of Directional Coupler characteristics
- 4) Determination of VSWR and reflection coefficient.
- 5) Determination of radiation pattern of horn antenna
- 6) Determination of radiation pattern and return loss of planar antenna.

(15)

SOFTWARE EXPERIMENTS :

- 1) Design and Simulation of Low pass and High pass filter.
- 2) Design and Simulation of Microstrip line
- 3) Design and Simulation of Filter using Microstrip line
- 4) Design and Simulation of Branch line coupler
- 5) Design and simulation of RF amplifier
- 6) Study of measurement of S-parameters of micro strip components using vector network analyzer

(15)

Total P: 30

REFERENCES:

1. David M Pozar , "Microwave Engineering", John Wiley and Sons, 2011.

19L712 DIGITAL COMMUNICATION ENGINEERING LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS:

- 1) Linear Block Coder and decoder
- 2) Cyclic Coder and decoder
- 3) Convolutional Coder
- 4) Power spectral density of different type of Line codes
- 5) Error performance of ASK,FSK and PSK schemes
- 6) Spread Spectrum Systems - DSSS ,FHSS

(15)

SOFTWARE EXPERIMENTS:

- 1) Viterbi decoder for decoding Convolutional codes
- 2) Tapped-Delay equalizer
- 3) Error performance of OFDM
- 4) Vector Signal Analysis of different modulation schemes
- 5) RAKE receiver
- 6) Modeling wireless fading channels
- 7) Early-Late Gate Synchronizer

(15)

Total P: 30

REFERENCES:

1. Proakis J G, Salehi M , "Contemporary communication systems using MATLAB", PWS Publishing company, 2013.
2. Dennis Silage , "Digital Communication Systems Using MATLAB and Simulink", Bookstand Publishing, 2016.

19L720 PROJECT WORK I

0 0 4 2

Identification of a real time problem in thrust areas

Developing a mathematical model for solving the above problem

Finalization of system requirements and specification

Simulation / Implementation of different solutions for the problem based on literature survey

Future trends in providing alternate solutions

Consolidated report preparation of the above

Total P: 60

SEMESTER - VIII

19L820 PROJECT WORK II

0 0 8 4

Identification of a real time problem in thrust areas
Developing a mathematical model for solving the above problem Finalization of system requirements and specification
Simulation / Implementation of different solutions for the problem based on literature survey
Future trends in providing alternate solutions
Consolidated report preparation of the above

Total P: 120

PROFESSIONAL ELECTIVES

19L001 SATELLITE COMMUNICATION

3 0 0 3

ELEMENTS OF SATELLITE COMMUNICATIONS AND ORBITAL ASPECTS : Brief history and current state of Satellite Communications - Satellite systems, Transmission and Multiplexing-Modulation-Multiple access-advent of Digital satellite communications. The Equations of the Orbit - Locating the Satellite in the Orbit - Orbital elements - Look angle - Elevation and Azimuth calculations - Geostationary orbit - Visibility - Orbital perturbations - Orbital effects in Communication system performance. (12)

EXPANDABLE LAUNCH VEHICLE : Space Transportation System (STS) - The mechanics of Launching a Synchronous satellite - The rocket equation - Powered flight - Injection into final orbit and orbital manoeuvres - Mission possibilities - Low thrust variations. (8)

SPACE CRAFT : Space craft subsystems - Altitude and Orbit Control System - Telemetry, Tracking and Command (TT&C) - Power systems - Description of communication system - Transponder - Implementations – Transmission Impairments - Space Craft Antennas - Equipment reliability. (8)

SATELLITE LINK : Basic Transmission Theory - System noise temperature and G/T ratio - Calculation of system noise temperature - Noise figure - Downlinks and Uplinks - Limits on link performance - Design of Satellite links for specified (C/N) - Rain attenuation model, Modulation and Multiplexing techniques (8)

SATELLITE SERVICES AND EARTH STATION : MSAT service, BSAT service, RADARSAT service, SAR SAT service, INTELSAT service, INMART SAT service, VSAT service, Satellite Navigation and the Global positioning system, chandrayaan, Earth station design for Low system noise temperature (9)

Total L: 45

TEXT BOOKS:

- 1.Tri T Ha , "Digital Satellite Communications", Tata McGraw Hill, 2014.
- 2.Timothy Pratt, Charles W Bostian, Jeremy Allnutt , "Satellite Communications", John Wiley and Sons, 2015.

REFERENCES:

- 1.Richaria M , "Satellite Communication Systems Design Principles", McGraw Hill, 2012.
- 2.Emanuel Fthenakis , "Manual of Satellite Communications", McGraw Hill, 2014.
- 3.Coolen M , "Satellite Communication", IEEE Publication, 2010.
- 4.Dennis Roddy , "Satellite Communications", Fourth, McGraw Hill, 2017.

19L002 DIGITAL SWITCHING SYSTEMS

3 0 0 3

DIGITAL SWITCHING : Functions of a switching system- Classification- - Message, packet and circuit switching - Electronic switching-Reed electronic systems - Switching networks- Single stage networks - cross point switches - gradings- forms of grading - Link systems-2, 3 and 4 stage networks - - Space and Time switching - time division switching networks - PBX switches (13)

SWITCHING SYSTEMS CONTROL AND SIGNALLING METHODS : Introduction-digital switching system fundamentals and evolution - call processing functions-common control-stored program control - Processor- Distributed processing - software-The 5ESS switching system - Review of dc signaling over audio frequency lines FDM carrier systems-Out-band and in -band signaling-PCM signaling - Inter register signaling- common channel signaling- Digital customer line signaling (13)

TRAFFIC ENGINEERING : Introduction to traffic and queuing Theory - Network Traffic Load and Parameters – Grade of Service Blocking Probability - Incoming traffic and service time characterization (7)

TELEPHONE NETWORK ORGANISATION : Analog and Digital networks - Subscriber Loop System – Switching Hierarchy

and Routing - Transmission Plan and Transmission Systems - Numbering, Charging (6)

MOBILE SWITCHING : The cellular concept - analog and digital network elements - channels-initialization- signaling - channel assignment-handoff digital cells.-fading and path loss - digital cells-fading and path loss (6)

Total L: 45

TEXT BOOKS:

- 1.Flood J E , "Telecommunications switching, Traffic and Networks", Pearson Education Ltd., 2011.
- 2.Viswanathan T , "Telecommunication Switching Systems and Networks ", Prentice Hall of India, 2015.

REFERENCES:

- 1.StephenW Gibson , "Cellular Mobile Radio Telephones", Prentice Hall of India, 2015.
- 2.John Ronayne , "An Introduction to Digital Communications switching", Wheeler publishing, 2012.
- 3.David J Goodman , "Wireless Personal Communication Systems", Addison Wesley Inc., 2010.

19L003 FIBER OPTIC COMMUNICATION

3 0 0 3

INTRODUCTION : Optical Spectral bands - Evolution of fiber optical system -Elements of Optical Fiber Systems - - Optical Fiber Modes and Configurations- Mode theory of Circular Wave guides - Single Mode Fiber - Graded Index fiber - Fiber Materials- Signal degradation in fibers-Advantages and applications of fiber optic transmission systems. (9)

OPTICAL TRANSMITTER : Optical sources- Light-Emitting Diodes (LEDs)- Laser Diodes -Light Source Linearity - Reliability Considerations-Comparison and applications - Transmitter Design. (9)

OPTICAL RECEIVER : Photo detectors-Photodiodes - Avalanche photo diodes- Comparisons of photo detector- Receiver Noise and sensitivity-Digital Receiver Performance-BER Calculation-Eye Diagrams. (9)

SYSTEM CONFIGURATIONS : Optical link design - Optical Power Launching and Coupling -System Design considerations - Optical amplifiers - EDFA - Raman amplifier- Multiplexing strategies - Wavelength division multiplexing ,OTDR. (9)

ADVANCES IN OPTICAL FIBER SYSTEMS : DWDM -SONET/SDH - Wavelength Routing Networks - Optical switches - Optical fiber LAN link - Ultra High Capacity Networks - OTN-Optical networking technology in enterprise. (9)

Total L: 45

TEXT BOOKS:

- 1.Keiser G , "Optical Fiber Communications", McGraw Hill, 2014.
- 2.John M. Senior , "Optical Fiber Communications Principles and Practice", PHI, 2014.

REFERENCES:

- 1.Rajiv Ramasami Kumar and Sivarajan N , "Optical Networks A Practical Perspective", Morgan Kaufmann Publishers, 2011.
- 2.Uyless Black , "Optical Networks-Third Generation Transport Systems", Pearson Education, 2012.
- 3.G.P. Agrawal , "Fiber optic Communication Systems", Fouth, John Wiley and sons, 2012.
- 4.K. Mynbaev and Lowell L Scheiner , "Fiber Optic Communication Technology", Prentice Hall, 2001.

19L004 RADAR COMMUNICATION

3 0 0 3

INTRODUCTION TO RADAR : Basics of radar, EM Waves & properties- applications of radar, radar frequencies- radar block diagram, Radar Coordinates, Radar equation for hard targets and the SNR-radar cross section of targets, Radar Resolution Elements, Pulse, CW and FMCW Radars-configurations, transmitter power- pulse repetition frequency, Duty Ratio, Pulse Compression, Coding (9)

DETECTION OF SIGNALS IN NOISE AND RADAR WAVEFORMS : probability density functions – probabilities of detection and false alarm-matched filter receiver-detection criteria – integration of radar pulses - constant-false alarm rate receivers - Radar Waveforms, Pulse Compression, Ambiguity Diagram. (9)

RADAR TRANSMITTER AND RECEIVER : Introduction- Types of Transmitters - linear-beam power tubes- solid-state RF power sources- magnetron- Klystron, crossed-filed amplifier- radar receiver- receiver noise figure- super heterodyne receiver, Digital Receivers, duplexers and receiver protectors- radar displays-Human Machine Interface(HMI) (9)

RADAR ANTENNA : Functions of radar antenna- antenna parameters- antenna radiation pattern and aperture illumination - reflector antennas- electronically steered phased array antennas- phase shifters – frequency - scan arrays-- architectures for phased arrays , radiators for phased arrays- mechanically steered planar array antennas- radiation pattern synthesis -effect of errors on radiation patterns - low side lobes antennas. (9)

MTI AND PULSE DOPPLER RADAR : Introduction to Doppler and MTI radar- delay –line cancellers- staggered pulse repetition frequencies- doppler filter banks- digital MTI processing - Moving target detector- limitations to MTI performance-

pulse Doppler radar-MTD, Tracking radar- monopulse tracking- conical scan and sequential lobing- comparison of trackers. tracking accuracy- low-angle tracking- Atmospheric & Weather Radars: Precipitation Radars, Doppler Weather Radar, Polarimetric Radar, Clear Air Radars. (9)

Total L: 45

TEXT BOOKS:

- 1.Merril I Skolnik , "Introduction to Radar Systems", Mc Graw-Hill, 2017.
- 2.Peebles P Z , "Radar Principles", Wiley, 2016.

REFERENCES:

- 1.Richard J Doviak , Dusan S Zrnic , "Doppler Radar and Weather Observations", Academic Press, 2014.
- 2.Bringi V N, Chandrasekar V , "Polarimetric Doppler Weather Radar", Cambridge University Press, 2012.
- 3.Richards M A, Scheer J A and Holm W A , "Principles of Modern Radar", Scitech Publishing, 2014.
- 4.Levanon N , "Radar Signals", Wiley-IEEE Press, 2012.

19L005 RADIO FREQUENCY INTEGRATED CIRCUITS

3 0 0 3

BASIC OF RF ELECTRONICS AND ISSUES IN RFIC DESIGN : Lumped element concept at RF - lumped and distributed regions lower frequency analog design - microwave design versus radio frequency integrated circuit design - Impedance levels for microwave and low-frequency analog design - noise - linearity and distortion in RF Circuits - dynamic range - filtering issues (7)

SEMICONDUCTOR DEVICE MODELING OF TECHNOLOGY : Basic operation and characteristic of bipolar junction transistor - Small -signal model of bipolar transistor - high frequency effects - noise in bipolar transistors - base shot noise-noise sources in the transistor model - bipolar transistor design considerations-CMOS transistor - impedance matching - tapped capacitors and inductors - the concept of mutual inductance - tuning a transformer - bandwidth of an impedance transformation network - quality factor of an LC resonator. (8)

DESIGN OF PASSIVE CIRCUIT ELEMENTS IN IC TECHNOLOGIES : Technology backend and metallization in IC technologies - sheet resistance and skin effect -parasitic capacitance and inductance - current handling in metal lines - design of inductors and transformers - characterization of inductor-layout of spiral inductors - on-chip transmission lines - high frequency measurements of on-chip passives - common De-Embedding techniques - packaging (8)

LOW NOISE AMPLIFIER : Basic amplifiers - amplifiers with feedback - noise in amplifiers - linearity in amplifiers - differential pair and other differential amplifiers - low-voltage topologies for LNAs and the use of on-chip transformers - DC bias networks - temperature effects - broad band LNA design (11)

MIXERS AND VOLTAGE-CONTROLLED OSCILLATORS : Mixers: mixing with nonlinearity - controlled transconductance mixer - double- balanced mixer - mixer with switching of upper quad - analysis of switching modulator - mixer noise - linearity - improving isolation - image reject - single -sideband mixers - CMOS mixers -Analysis of an oscillator as a feedback system - phase noise - VCO automatic -amplitude control circuits (11)

Total L: 45

TEXT BOOKS:

- 1.John Rogers , Calvin Plett , "Radio Frequency Integrated Circuit Design", Artech House, 2011.
- 2.Radmanesh M M , " Radio Frequency and Microwave Electronics, ", Asia, 2011.

REFERENCES:

- 1.Less Besser , Rowan Gllmore , " Practical RF Circuit Design for Modern Wireless Systems," , Artech House, 2011.
- 2.Stephan A Mass , "Non-Linear Microwave and RF circuits", Artech House, 2008.
- 3.Ferri Losee , "RF Systems, Components and Circuits handbook", Artech house, 2018.
- 4.Larson L E , "RF and Microwave Circuit for Wireless Applications", Artech House, 2015.

19L006 COMPUTATIONAL ELECTROMAGNETICS

3 0 0 3

EM REVIEW : E-field - permittivity – Coulomb's Law - Flux of a vector field – Gauss's Law for E fields (Integral) - divergence – Gauss's Law for E fields (Differential) B-field - permeability - Biot-Savart law – Gauss's law for B fields (integral and differential) - Divergence Theorem - circulation of a vector field - curl - Stokes Theorem. Gradient. Laplacian. Poisson and Laplace equations. Ampere-Maxwell Law - Faraday-Maxwell Law. Continuity equation. Constitutive equations. (9)

NUMERICAL DIFFERENTIATION : Forward difference - backward difference - central difference. Higher order derivatives. Partial derivatives. Solution of Linear Systems: Matrix equivalent. Solution sets. Direct vs iterative methods. Sparse matrices. Libraries. Gaussian Elimination. Gauss-Seidel method. Numerical Integration Riemann Sums Left/right-point rules Midpoint - trapezoid - Simpsons rules Error bounds-Numerical Integration Examples (9)

METHOD OF MOMENTS : Greens Functions; Surface equivalence principle; Electrostatic formulation; Magnetostatic formulation; Electric Field Integral Equation; Magnetic Field Integral Equation; Direct and Iterative Solvers; (9)

FINITE DIFFERENCE TIME DOMAIN METHODS : 1D wave propagation - yee Algorithm - Numerical dispersion and stability - perfectly matched absorbing boundary conditions - Dispersive materials. Antenna and scattering problems with FDTD - non-uniform grids - conformal grids – periodic structures. (10)

APPLICATIONS OF CEM : Antennas - biological electromagnetic effects - electronic packing and high speed circuits - microwave devices and circuits - environmental issues. surveillance and intelligence gathering - homeland security - signal integrity. (8)

Total L: 45

TEXT BOOKS:

1. Walton C Gibson , "The Method of Moments in Electromagnetics", CRC Press, 2014.
2. Peterson, Scott L Ray and Raj Mittra , "Computational Methods for Electromagnetics", IEEE Press Series on Electromagnetic Wave Theory, 1998.

REFERENCES:

1. Roger F Harrington , "Field Computation by Moment Methods", IEEE Press, 1993.
2. Taflove A , Hagness SC , "Computational Electrodynamics: The Finite Difference Time Domain Method", Artech House, 2004.

19L007 ADVANCED RADIATING SYSTEM

3 0 0 3

ANTENNA FUNDAMENTALS : Antenna fundamental parameters Radiation integrals - Radiation from surface and line current distributions - dipole - monopole - loop antenna; Mobile phone antenna- base station - hand set antenna; Image; Induction - reciprocity theorem - Broadband antennas and matching techniques - Balance to unbalance transformer - Introduction to numerical techniques. (9)

RADIATION FROM APERTURES : Field equivalence principle - Radiation from Rectangular and Circular apertures - Uniform aperture distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna - aperture blockage - and design consideration. (9)

ARRAY ANTENNA : Uniform array; Phased array - beam scanning - grating lobe - feed network - Linear array synthesis techniques - Binomial and Chebyshev distributions - Super Directivity - Planar array- Circular array - Design problems. (9)

MICRO STRIP ANTENNA : Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch - Rectangular patch - Circular patch - and Ring antenna - radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of microstrip array antenna. (9)

EMC ANTENNA AND ANTENNA MEASUREMENTS : Concept of EMC measuring antenna; Tx and Rx antenna factors; Log periodic dipole - Bi-conical - Ridge guide - Multi turn loop; Antenna measurement and instrumentation - Gain - Impedance and antenna factor measurement; Antenna test range Design. (9)

Total L: 45

TEXT BOOKS:

1. Balanis A , "Antenna Theory Analysis and Design", Second, John Wiley and Sons, NewDelhi, Reprint 2018.
2. John D krauss , "Antennas", 3rd Edition, Mc Graw-Hill, Inc, New York, 2018.

REFERENCES:

1. Bahl I J , Bhartia P , "Microstrip Antennas", 2nd Edition, Artech House, NewYork, 2015.
2. Stutzman W L , Thiele G A , "Antenna Theory and Design", 2nd Edition, John Wiley and Sons Inc., Singapore, 2014.

19L008 SMART ANTENNAS

3 0 0 3

INTRODUCTION : Antenna gain, Phased array antenna, power pattern, beam steering, degree of freedom, optimal antenna, adaptive antennas, smart antenna - key benefits of smart antenna technology, wide band smart antennas, Digital radio receiver techniques and software radio for smart antennas. (9)

NARROW BAND PROCESSING : Signal model conventional beamformer, null steering beamformer, optimal beamformer, Optimization using reference signal, beam space processing. (8)

ADAPTIVE PROCESSING : Sample matrix inversion algorithm, unconstrained LMS algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, Neural network approach, Adaptive beam space processing, Implementation issues. (9)

BROADBAND PROCESSING : Tapped delay line structure, Partitioned realization, Derivative constrained processor, Digital beam forming, Broad band processing using DFT method. (9)

DIRECTION OF ARRIVAL ESTIMATION METHODS : Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm – root music and cyclic music algorithm, the ESPRIT algorithm. **DIVERSITY COMBINING**: Spatial diversity selection combiner, switched diversity combiner, equal gain combiner, maximum ratio combiner, optical combiner. (10)

Total L: 45

TEXT BOOKS:

1. Lal Chand Godara, "Smart Antennas", 1st Edition, CRC press, 2016.
2. Balanis A, "Antenna Theory Analysis and Design", 4th Edition, John Wiley and Sons, New York, 2015.

REFERENCES:

1. Joseph C Liberti, Jr, Theodore S Rappaport, "Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMA Applications", Prentice Hall, 1999.
2. Robert A. Monzingo, R.L. Haupt, T.W. Miller, "Introduction to Adaptive Arrays", Yesdee Publishing Pvt. Ltd, 2012.

19L009 SPEECH SIGNAL PROCESSING

3 0 0 3

SPEECH SIGNAL MODELLING : Speech signal characteristics and classifications - Speech production mechanism - Acoustic Theory of speech production - Source - Filter model - Lossless Tube Models - Digital Model of speech signals. (9)

SPEECH SIGNAL ANALYSIS : Time domain Analysis for speech processing - Short time energy and magnitude - short time average zero crossing - Speech vs silence discrimination - Pitch period estimation using autocorrelation function - Short time Fourier analysis- Definition and properties - Design of digital filter banks - Pitch detection - Analysis and synthesis. (12)

SPEECH CODING IN TIME DOMAIN : Linear predictive coding (LPC) - principle - solution of LPC equation – Cholesky decomposition method - Durbin's method - Lattice formulation (6)

SPEECH CODING IN FREQUENCY DOMAIN : Frequency domain interpretation of LPC - LPC Applications - CELP - Subband coding - Transform coding - Vocoders and cepstral vocoders - Vector quantiser coders (6)

SPEECH RECOGNITION : Problems in ASR - Dynamic Time warping - Isolated word recognition - pattern matching – Speaker independent recognition- Pattern classification – Connected word recognition – Speaker identification/Verification - Hidden Markov model (12)

Total L: 45

TEXT BOOKS:

1. Rabiner L R, Schaffer R W, "Digital Processing of Speech Signals", Pearson Education - India, 2015.
2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing", Pearson Education - India, 2015.

REFERENCES:

1. Owens FJ, "Signal Processing of Speech", Macmillan, 2015.
2. Rabiner L R, K Juang B H, "Fundamentals of speech Recognition", Pearson Education - India, 2015.
3. John R Deller Jr, John H L Hansen, John G Proakis, "Discrete Time Processing of Speech Signal", IEEE press, 2015.

19L010 MULTIMEDIA COMPRESSION TECHNIQUES

3 0 0 3

INTRODUCTION : Compression Techniques - Overview of information theory - lossless and lossy coding– Multimedia components and their characteristics -Text, sound, images, graphics, animation, video- Huffman coding – Non-Binary Huffman codes – adaptive Huffman coding (8)

ARITHMETIC CODING AND DICTIONARY TECHNIQUES : Introduction- coding a sequence – generating deciphering the tag – Generating a binary code –Static and Adaptive dictionary – LZ77, LZ78, LZW approach – Applications - Facsimile encoding – run length coding – MH, MR, MMR and JBIG. Scalar and Vector Quantization (10)

AUDIO COMPRESSION : Audio compression techniques - frequency domain and filtering - basic sub-band coding - application to speech coding - G.722 - application to audio coding - MPEG audio - silence suppression – speech compression techniques –Vocoders. (10)

IMAGE COMPRESSION : Predictive techniques - DPCM, DM - DCT, JPEG, Wavelet based compression: quad-trees, EZW, SPIHT, JPEG-2000. (9)

VIDEO COMPRESSION : Video signal representation –Motion compensation – MPEG standards - Motion estimation techniques - H.261 family of standards - Motion video compression (8)

Total L: 45

TEXT BOOKS:

- 1.Sayood Khaleed , "Introduction to data compression", 5th Edition, Morgan Kauffman, 2017.
- 2.Yun Q. Shi, Hulfang Sun , "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards", third Edition, CRC Press, 2019.

REFERENCES:

- 1.Salomon D , "Data Compression The Complete Reference", Springer, 2014.
- 2.SalomonD , "A Guide to Data Compression Methods", Springer, 2012.

19L011 WAVELETS AND ITS APPLICATIONS

3 0 0 3

FOURIER ANALYSIS : Fourier basis & Fourier Transform – failure of Fourier Transform – Need for Time-Frequency Analysis – Heisenberg’s Uncertainty principle – Short time Fourier transform (STFT)- short comings of STFT- Need for Wavelets (9)

CWT AND MRA : Wavelet basis – Continuous time Wavelet Transform (CWT) – need for scaling function – Multi-Resolution Analysis (MRA) – important wavelets: Haar, Mexican hat, Meyer, Shannon, Daubachies (9)

INTRODUCTION TO MULTIRATE SYSTEMS : Decimation and Interpolation in Time domain - Decimation and Interpolation in Frequency domain – Multi rate systems for a rational factor (9)

FILTER BANKS AND DWT : Two channel filter bank – Perfect Reconstruction (PR) condition – relationship between filter banks and wavelet basis – DWT – Filter banks for Daubachies wavelet function. (9)

ADVANCED TOPICS AND APPLICATIONS : Introduction to Multiwavelets, Multidimensional wavelets – wavelet packet transform, Feature extraction using wavelet coefficients, Image compression, Wavelet based denoising (9)

Total L: 45

TEXT BOOKS:

- 1.Jaideva C Goswami, Andrew K Chan , "Fundamentals of Wavelets – Theory, Algorithms and Applications", John Wiley & Sons, Singapore, 2011.
- 2.Soman K P, Ramachandran K I , "Insight into wavelets from Theory to practice", Prentice Hall, New Delhi, 2010.

REFERENCES:

- 1.Sidney Burrus C , "Introduction to Wavelets and Wavelets Transforms", Prentice Hall, New Delhi, 2002.
- 2.Stephane G Mallat , "A Wavelet Tour of Signal Processing", Academic Press, India, 2009.
- 3.Raghuveer M Rao, Ajit S Bopardikar , "Wavelet Transforms: Introduction to Theory & Applications", Wavelet Transforms: Introduction to Theory & Applications, New Delhi, 2003.

19L012 ADVANCED DIGITAL SIGNAL PROCESSING

3 0 0 3

INTRODUCTION : DT signals and DT systems - DTFT - Random variables and random process – Autocorrelation function - Power spectral density (5)

MULTIRATE SIGNAL PROCESSING : Down sampling - Up sampling - Noble identities - cascading sampling rate convertors - Decimation with transversal filters - interpolation with transversal filters - decimation with polyphase filters - interpolation with polyphase filters - decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors (10)

POWER SPECTRUM ESTIMATION : Non parametric methods - Periodogram - Modified Periodogram - Bartlett - Welch & Blackman Tukey methods - Performance comparison - Parametric methods - Auto Regressive spectrum estimation - Relationship between autocorrelation and model parameters - Moving Average and Auto Regressive Moving Average spectrum estimation (10)

ADAPTIVE FILTERS : Introduction to Wiener Filter - Adaptive Filter Applications - System identification - Inverse modeling - Prediction - Interference Cancellation - Adaptive linear combiner - Performance function - Gradient and Minimum Mean Square error - Gradient search by steepest descent method - LMS algorithm - Convergence of LMS algorithm - Learning curve - Introduction to RLS algorithm (10)

WAVELET TRANSFORMS : Need for Time Frequency Analysis - Short time Fourier transform - short comings of STFT - Need for Wavelets - Continuous time Wavelet Transform - Multi Resolution Analysis - Haar and Daubechies wavelet functions - Introduction to Discrete Wavelet Transform (10)

Total L: 45

TEXT BOOKS:

- 1.Monson H.Hayes , "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 2015.
- 2.Ifeachor E C, Jervis B. W. , "Digital Signal Processing: A Practical Approach", Prentice Hall, 2015.

REFERENCES:

- 1.K.P.Soman, K.I.Ramach, N.G.Resmi , "Insight into Wavelets from Theory to Practice", Third Edition, PHI Learning Private limited, 2015.
- 2.Jaideva C Goswami , Andrew K Chan , "Fundamentals of Wavelets – Theory, Algorithms and Applications", John Wiley and Sons, 2015.

19L013 PATTERN RECOGNITION AND MACHINE LEARNING**3 0 0 3**

PATTERN CLASSIFIER : Pattern recognition overview-Feature extraction-Statistical Pattern Recognition-Supervised & Unsupervised Learning; Bayes decision Theory, Linear discriminant functions, Pattern classification by distance functions – Minimum distance pattern classifier (9)

STRUCTURAL PATTERN RECOGNITION : Elements of formal grammars –String generation as pattern description – Recognition of syntactic description –Parsing –Stochastic grammars and applications –Graph based structural representation (8)

COMPUTATIONAL LEARNING THEORY : Basics , Types of Learning - Designing a learning system – concept learning - Find-s – Candidate Elimination - PAC Learnability- Sample complexity for finite and Infinite hypothesis spaces-VC Dimension (9)

LINEAR MODELS : Linear Models For Regression – Linear Regression Models, Maximum Likelihood Estimation - Least Squares, The Bias-Variance Decomposition, Bayesian Linear Regression, Linear Models for Classification, Linear Discriminant Analysis. (9)

NEURAL NETWORKS AND KERNEL METHODS : : Neural Networks - Feed-forward Networks - Network Training - Delta Rule- Gradient Descent - Error Backpropagation - Constructing KernelsRadial Basis Function Networks. Gaussian Processes - Maximum Margin Classifiers – SVM (10)

Total L: 45**TEXT BOOKS:**

- 1.Christopher Bishop , "Pattern Recognition and Machine Learning", Springer-Verlag, New York, 2013.
- 2.Narasimha Murty, Susheela Devi V , "Pattern Recognition: An Algorithmic Approach", Pattern Recognition: An Algorithmic Approach, India, 2011.

REFERENCES:

- 1.Tom M. Mitchell , "Machine Learning", McGraw Hill, 1997.
- 2.Trevor Hastie, Robert Tibshirani, Jerome Friedman , "The Elements of Statistical Learning - Data Mining, Inference, and Prediction", 2nd Edition, Springer-Verlag, New York, 2013.
- 3.Sergios T, Konstantinos K , "Pattern Recognition", 4th Edition, Academic Press, 2008.

19L014 WIRELESS SYSTEMS AND STANDARDS**3 0 0 3**

INTRODUCTION TO CELLULAR STANDARDS : 2G GSM - Cell structure - Frequency Bands and Channels- Call processing - Identity numbers - Frame structure - Interfaces - GMSK modulation - Voice and data processing - GPRS - EDGE - EDGE+ - CDMA signal processing - IS-2000 system - Frequency bands - Channel allocation - CDMA cell capacity - services provided by IS-2000 - 1xEVDO signal processing and data services-3G UMTS signal processing - WCDMA - HSPA - HSPA+ - Towards 4G - LTE and LTE advanced. (9)

WIRELESS SYSTEMS : Advanced Mobile Phone Systems (AMPS) - Characteristics - Operation - General Working of AMPS Phone System - Global System for Mobile Communication - Frequency Bands and Channels - Frames - Identity Numbers - Layers - Planes and Interfaces of GSM - International Mobile Telecommunications (IMT-2000) - Spectrum Allocation - Services provided by 3G Cellular Systems - Harmonized 3G Systems - Universal Mobile Telecommunications Systems (UMTS). (9)

THE IEEE 802.11 WLAN STANDARD : Introduction to IEEE 802.11 - General Description - Medium Access Control (MAC) - Physical Layer for IEEE 802.11 Wireless LANs; Radio systems - IR Systems Applications. (9)

THE IEEE 802.16 WIMAX STANDARD : Introduction to IEEE 802.16 - General Description - Medium Access Control (MAC) - Radio systems - Physical Layer- Evolution to 802.16m - Bluetooth - Zigbee (9)

RECENT ADVANCES : Introduction - Ultra Wide Band (UWB) Technology - Characteristics - Signal Propagation - Current Status and Applications - Advantages - Disadvantages - Challenges and Future Directions. (9)

Total L: 45

TEXT BOOKS:

1. Assuncion Santamaria, Francisco Lopez-Hern, ez , "Wireless LAN Standards and Applications", Artech House, 2001.
2. Dharma Prakash Agarwal , Qing- An zeng , "Introduction to Wireless and Mobile Systems", Vikas publishing House, 2004.

REFERENCES:

1. Neeli Prasad , An , "WLAN System & Wireless IP for Next Generation Communications", Artec House, 2002. 2009.

19L015 WIRELESS SENSOR NETWORKS

3 0 0 3

INTRODUCTION : Challenges and constraints - Comparison of sensor network with ad hoc network - WSN Applications - case studies related to Structural monitoring - Healthcare, Precision Agriculture - Underground mining (9)

ARCHITECTURE : Single node architecture - sensing subsystem - processing subsystem - communication interfaces - Operating systems - Network architecture - Sensor network scenarios - Design principles – Gateway Concepts. (9)

MEDIUM ACCESS CONTROL : MAC protocols - MAC low duty cycle protocols and wakeup concepts - contention-based protocols - SMAC, IEEE 802.15.4 MAC (9)

ROUTING IN WIRELESS SENSOR NETWORKS : Energy-efficient unicast - Broadcast and multicast - Data centric Routing protocols in WSNs - Data Aggregation, Hierarchical Routing protocols Location based routing protocols (9)

NODE AND NETWORK MANAGEMENT : Power Management - Local Power Management Aspects - Time Synchronization in Wireless Sensor Networks - Ranging techniques - Range based Localization - range free localization (9)

Total L: 45

TEXT BOOKS:

1. Holger Karl, Andreas Willig , "Protocol and Architecture for Wireless Sensor Networks", John Wiley publication, 2007.
2. Walteneus Dargie, Christian Poellabauer , ", "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley, 2010.

REFERENCES:

1. Fei Hu , Xiaojun Cao , "Wireless Sensor Networks , Principles and Practice", CRC Press, 2010.
2. Sudip Misra, Isaac Woungang, Subhas Chandra Misra , "Guide to Wireless Sensor Networks", Springer, 2009.
3. Kazem Sohraby, Daniel Minoli, Taieb Znati , "Wireless Sensor Networks: Technology, Protocols, and Applications", John Wiley & Sons, 2007.
4. Ian Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", John Wiley & Sons, USA, 2010.

19L016 WIRELESS NETWORKING

3 0 0 3

WIRELESS LOCAL AREA NETWORK : Introduction to Wireless LAN s – Topologies, IEEE 802.11 WLAN – Architecture and Services, Physical Layer- MAC SubLayer –MAC Management SubLayer , Other IEEE 802.11 Standards - HIPERLAN, WiMAX. (8)

ADHOC WIRELESS NETWORKS : Characteristics of Adhoc Networks, MAC Protocols – Routing Protocol - TCP Over Ad Hoc Wireless Networks (9)

WIRELESS PERSONAL AREA NETWORKS : : Introduction to Bluetooth - Architecture, Protocol Stack, Topology, Application. Wireless Sensor Network – Architecture, Data Dissemination and Gathering. Zigbee Technology – Components, Network topologies and architecture (9)

MOBILE NETWORK AND TRANSPORT LAYER : TCP Enhancements for Wireless Networks – Implementation of Wireless TCP – Mobile IP and Session Initiation Protocol (9)

WIRELESS WIDE AREA NETWORKS : GSM network Architecture , channels , Call procedures, hand off procedures. CDMA System Architecture, Channels, hand off procedure. Digital cellular technology – Evolution, W-CDMA air interface, CDMA 2000 cellular technology. Introduction to 4G and 5G technologies (12)

Total L: 45

TEXT BOOKS:

1. Vijay.K. Garg , "Wireless Communication and Networking", Morgan Kaufmann Publishers, 2017.
2. Siva Ram Murthy C, Manoj B S , "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2017.

REFERENCES:

1. T L singal , "Wireless communciations " , Mcgraw Hill Education, 2016.
2. Pahalavank , Krishnamurthy P , "Principles of Wireless Networks - A Unified Approach", Prentice Hall, 2002.
3. William Stallings , "Wireless Communications and Networks", 2nd Edition, Pearson/ Prentice Hall India, 2007.

19L017 LONG TERM EVOLUTION TECHNOLOGIES

3 0 0 3

LTE INTRODUCTION AND NETWORK ARCHITECTURE : Motivation to LTE - Evolution of Architecture - Standardization process in 3GPP - Technologies for LTE - Network Architecture - Core Network - Access Network - Roaming Architecture - Protocol Architecture - Quality of service and EPS Bearers - S1 and X2 E-UTRAN Network Interfaces. (9)

CONTROL PLANE AND USER PLANE PROTOCOLS : Radio Resource Control - PLMN and Cell Selection - Paging - User Plane Protocol Stack - Packet Data Convergence Protocol - Radio Link Control - Medium Access Control. (8)

ORTHOGONAL FREQUENCY DIVISION MULTIPLE ACCESS & MIMO TECHNIQUES : History of OFDM Development - OFDM- OFDMA - Parameter Dimensioning. Fundamentals of Multiple antenna theory - MIMO Signal Model – Single User MIMO - Multi User MIMO - MIMO Schemes in LTE. (9)

PHYSICAL LAYER FOR DOWNLINK : Transmission Resource Structure - Signal Structure - Downlink operation. Synchronization and Cell Search - Synchronization sequences and cell search in LTE - Coherent versus Non-Coherent Detection. (9)

PHYSICAL LAYER FOR UPLINK : Uplink Physical Layer Design - SC- FDMA Principle - SC-FDMA Design in LTE. Uplink Physical channel structure - Physical uplink shared Data channel Structure - Uplink control channel Design - Multiplexing of control signaling - ACK/NACK Reception - Uplink transmission procedures- Timing Control - Power control. (10)

Total L: 45

TEXT BOOKS:

1. Stefania Sesia, Issam Toufik , Matthew Baker , "LTE – The UMTS Long Term Evolution: From Theory to Practice", John Wiley & Sons, 2011.
2. Christopher Cox , "An introduction to LTE – LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications", John Wiley & Sons, 2014.

REFERENCES:

1. Moray Rumney , "LTE and Evolution to 4G Wireless: Design and Measurement Challenges", Agilent Technologies, 2013.

19L018 NETWORK SECURITY

3 0 0 3

SECURITY PROBLEM : Security Problem in Computing-Security services - Attacks-Mechanism-Points of security vulnerability - Methods of defense-Controls-Effectiveness of control -Introduction to cryptography and steganography - Plan of attack-attack on encryption - Standards-Standard setting organizations (9)

SYMMETRIC CRYPTOGRAPHY : Encryption and Decryption-substitution-transposition - Block ciphers-Data Encryption Standard- -advance Encryption Standard-Triple DES-RC5,Stream cipher- RC4 - Block Cipher modes - Differential & Linear Cryptanalysis (9)

PUBLIC KEY ENCRYPTION : Number Theory basics - RSA-key management-Diffie-Hellman key exchange - Elliptic curve cryptography (9)

MESSAGE AUTHENTICATION : Requirements of authentication - HASH functions –SHA algorithm-MD5 - HMAC- Digital signature standards (9)

NETWORK AND SYSTEM SECURITY : Authentication applications - E-mail Security - IP security - Web security - Intruders -malicious Software - Firewalls (9)

Total L: 45

TEXT BOOKS:

1. William Stallings , "Cryptography & Network Security: Principles & Practices", Seventh Edition, Pearson Education Limited, 2017.
2. Behrouz A.Forouson , "Cryptography & Network Security", Third, Tata McGraw hill, 2015.

REFERENCES:

1. Charles P. Pleeeger , "Security in Computing", Fifth edition, Prentice Hall, 2015.

19L019 FPGA BASED SYSTEM DESIGN

3 0 0 3

FPGA DESIGN FLOW AND ARCHITECTURES : Digital IC design flow-The role of FPGAs in digital design-Goals and techniques-Hierarchical design-CAD Tools. FPGA architectures-Configurable logic blocks-configurable I/O blocks-Programmable interconnect-clock circuitry-Xilinx FPGA architecture-Programming Technologies: Antifuse, SRAM, EPROM,EEPROM. (9)

VERILOG HDL : HDL overview-Modules and ports-compiler directives-data types-operands and operators-gate level modeling-data flow modeling-behavioral modeling-structural modeling-primitives-Tasks and functions- Writing test bench. (9)

ARCHITECTING SPEED AND TIMING ISSUES : High Throughput - Low Latency - Timing - Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, reorder Paths. **CLOCKING AND METASTABILITY**: Set up time hold time-setup time hold time violations-critical path-calculation of maximum clock frequency- metastability - synchronizers-design examples. (9)

ARCHITECTING AREA AND POWER : Architecting Area - Rolling Up the Pipeline - Control-Based Logic Reuse - Resource Sharing - Impact of Reset on Area - Resources Without Reset, Resources Without Set, Resources Without Asynchronous Reset, Resetting RAM, Utilizing Set/Reset Flip-Flop Pins. Architecting Power - Clock Control, Clock Skew, Managing Skew, Input Control, Reducing the Voltage Supply, Dual-Edge Triggered Flip-Flops, Modifying Terminations. (9)

EMBEDDED SYSTEM DESIGN WITH FPGA : Processors - Interfaces - Zynq System-on-chip Development - IP based Design - Hardware-Software Co-design for Zynq - Software Development Tools - Real-time Applications. (9)

Total L: 45

TEXT BOOKS:

1. Michael D. Ciletti , "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson, 2011.
2. Steve Kilts , "Advanced FPGA Design Architecture, Implementation, and Optimization", First Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.

REFERENCES:

1. Crockett H. Louise, Ross A. Elliot, Martin A. Enderwitz , "The Zynq Book Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC", First Edition, Strathclyde Academic Media, 2014.
2. Charlet H. Roth, Lizy Kurian John, Byeong Kil Lee , "Digital Systems Design using Verilog", Cengage Learning, 2016.
3. Zainalabedin Navabi , "Verilog Digital System Design", Second Edition, McGraw-Hill Education, 2005.
4. Ming-Bo Lin , "Digital System Designs and Practices: Using Verilog HDL and FPGAs", First Edition, Wiley, 2008.

19L020 ANALOG VLSI CIRCUITS

3 0 0 3

INTEGRATED CIRCUIT DEVICES MODELING : Semiconductors and pn junctions - MOS transistors - Advanced MOS modeling - Bipolar junction transistors and its modeling (9)

ANALOG CIRCUIT BUILDING BLOCKS : Switches - Active resistors - Current sources and sinks - Current mirrors - Simple Cascade and Wilson Current Mirrors - Voltage and current references - Analog multipliers - (9)

AMPLIFIERS : MOS and BJT amplifiers , Frequency Response - CMOS and BJT differential amplifiers - Characterization of Op-Amp - Design of two stage op-amp - Op-amps with output stage - Comparators – Two Stage and Latched Comparators - PLL (9)

D/A AND A/D CONVERTERS : Analog signal processing -Parallel D/A converter: Current scaling , Voltage scaling and Charge scaling - Serial D/A converters - A/D converters: Serial A/D converters, Successive approximation A/D - parallel - High performance A/D converters - Oversampling Converters. (9)

FILTERS : Active RC Filters - Low pass filters - High pass filters - Bandpass filters - Switched capacitor filters. (9)

Total L: 45

TEXT BOOKS:

1. Jacob Baker Lee H W and Boyce D E , "CMOS Circuit Design, Layout and Simulation", Fourth, John Wiley & Sons, New Jersey, 2019.
2. David A Johns and Ken Martin , "Analog Integrated Circuit Design", Second, John Wiley & Sons, USA, 2013.

REFERENCES:

1. Phillip Allen and Douglas R Holdberg , "CMOS Analog Circuit Design", Third, Oxford University Press, New York., 2013.
2. Behzad Razavi , "Design of Analog CMOS Integrated Circuits", Second-Indain, Tata McGraw Hill, New Delhi, 2017.
3. Randall L Geiger Phillip E Allen and Noel R. Strader , "VLSI Design techniques for Analog and Digital Circuits", McGraw Hill, New Delhi, 2010.

19L021 LOW POWER VLSI DESIGN

3 0 0 3

PRINCIPLES OF LOW POWER VLSI DESIGN : Need for Low power VLSI chips - Sources of Power Dissipation – Dynamic Power Dissipation - Charging and Discharging of Capacitance – Short Circuit Current in CMOS Circuits - CMOS Leakage current – Static Current - Basic Principles of Low Power VLSI Design (9)

POWER ANALYSIS : Simulation power Analysis - Gate-Level Analysis - Architecture level Analysis – Data Correlation Analysis – Monte Carlo Simulation - Probabilistic Power Analysis Techniques (9)

POWER REDUCTION AT THE CIRCUIT LEVEL : Transistor and Gate Sizing – Equivalent Pin Ordering – Network Restructuring and Reorganization – Special Latches and Flip Flops – Low Power Digital Cell Library – Adjustable Device Threshold Voltage (9)

POWER REDUCTION AT THE LOGIC LEVEL : Gate Reorganization – Signal Gating – Logic Encoding – State Machine Encoding – Precomputation Logic (7)

POWER REDUCTION AT THE ARCHITECTURE AND SYSTEM LEVEL : Power and Performance management – Switching Activity Reduction – Parallel Architecture with Voltage Reduction – Flow Graph Transformation - **ADVANCED TECHNIQUES** : Adiabatic Computation - Pass Transistor Logic Synthesis - Power Reduction in Clock Networks - CMOS Floating Node - Low Power Bus-Software power estimation and optimization techniques (11)

Total L: 45

TEXT BOOKS:

1. Gary K Yeap , "Practical Low Power Digital VLSI Design", Kluwer academic publishers, 2002.
2. Kaushik Roy , Sharat C. Prasad , "Low Power CMOS VLSI circuit Design", John Wiley & Sons, 2009.

REFERENCES:

1. Kuo J B , Lou J H , "Low Voltage CMOS VLSI Circuits", John Wiley & Sons, 2001.
2. AP Chandrakasan, RW Brodersen , "Low Power Digital CMOS Design", Kluwer Academic Publishers, 1995.

19L022 NANO ELECTRONICS

3 0 0 3

OVERVIEW : Nano devices, Nano materials, Nano characterization. Definition of Technology node, Basic CMOS Process flow - MOS Scaling theory, Issues in scaling MOS transistors : Short channel effects, Description of a typical 65 nm CMOS technology - Requirements for Non classical MOS transistor. (8)

MOS CAPACITOR : Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO₂ vs High - k gate dielectrics. Integration - issues of high - k . Interface states, bulk charge, band offset, stability, reliability - Qbd high field, possible candidates, CV and IV techniques. (10)

METAL GATE TRANSISTOR : Motivation, requirements, Integration Issues - Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot. (7)

SOI NANO TRANSISTOR : SOI - PDSOI and FDSOI. Ultrathin body SOI - double gate transistors, integration issues. Vertical transistors - FinFET and Surround gate FET. Metal source/drain junctions - Properties of Schottky junctions on Silicon, Germanium and compound semiconductors - Workfunction pinning. (10)

HETERO STRUCTURE BASED DEVICES : Type I, II and III Heterojunction, Si - Ge heterostructure, hetero structures of III - V and II - VI compounds - resonant tunneling devices, MODFET/HEMT, Carbon nanotubes based devices – CNFET, characteristics, Spin - based devices – spinFET, characteristics. (10)

Total L: 45

TEXT BOOKS:

1. Mircea Dragoman, Daniela Dragoman. , "Nanoelectronics Principles and Devices", Second, Artech house, 2008.
2. Shunri Oda, David Ferry , "Silicon Nanoelectronics", Taylor & Francis, 2006.

REFERENCES:

1. Hanson. , "Fundamentals of Nanoelectronics", Pearson Education, 2009..
2. E. Kasper, D. J. Paul. , "Silicon Quantum Integrated Circuits Silicon-Germanium Heterostructures Devices: Basics and Realisations", Springer, 2005.
3. H.R. Huff, D.C. Gilmer. , "H.R. Huff and D.C. Gilmer. High Dielectric Constant Materials for VLSI MOSFET Applications , .", Springer, 2005.
4. Mark Lundstrom and Jing Guo. , "Nanoscale Transistors: Device Physics, Modeling and Simulation Springer", Springer, 2005.

19L023 DEVICE MODELING

3 0 0 3

INTRODUCTION TO SEMICONDUCTOR PHYSICS AND DIODE MODELLING : Quantum Mechanics – Boltzman transport equation - Continuity equation - Poisson equation, Junction and Schottky diodes in monolithic technologies - static and dynamic behavior - small and large signal models - SPICE models. (10)

INTEGRATED MOS CAPACITANCE : Band diagram - flatband condition and flat band voltage - surface accumulation, surface depletion - threshold condition and threshold voltage, charge versus gate voltage, MOS C - Characteristics, Poly Si gate depletion - effective Increase In Tox (10)

VLSI FABRICATION TECHNIQUES : An overview of wafer fabrication, wafer processing - oxidation - patterning - Diffusion - Ion implantation - Deposition - Silicon Gate nmos process - CMOS process - nwell - pwell - Twin tub - Silicon on Insulator - CMOS process enhancements - Interconnects circuit elements (9)

INTEGRATED MOS TRANSISTOR : nMOS and PMOS Transistor - Threshold voltage - Threshold voltage equations - MOS device equations - Basic DC equations Second order effects - Small signal AC Characteristics - MOS models SPICE model, EKV Model, BSIM Model. Technology scaling for cost, speed and power consumption, Subthreshold Current –Subthreshold Swing, Threshold voltage Roll Off - Short Channel Leakage, reducing gate insulator electrical thickness And Tunneling Leakage, Short Channel Effects. (10)

INTEGRATED THIN BODY AND MULTIGATE TRANSISTOR : Ultra Thin body, SOI and Multigate MOSFET - FINFET. MOSFET Compact Model for Circuit Simulation using Verilog A. (6)

Total L: 45

TEXT BOOKS:

- 1.Chenming C.Hu , "Modern Semiconductors for Integrated Circuits Prentice Hall", First, Prentice Hall, 2010.
- 2.Tyagi M S , "Introduction to Semi-conductor Materials and Devices", John Wiley, 2008..

REFERENCES:

- 1.Richard S. Muller, Theodore I. Kamins , "Device Electronics for Integrated circuits", John Wiley, 2003..
- 2.Yannis Tsividis , "Operation and Modeling of the Mos transistor", Oxford University Press, .
- 3.Neil Weste and David Harris , "A Circuits and Systems Perspective", Pearson., 2010.

19L024 SYSTEM-ON-CHIP DESIGN

3 0 0 3

SOC INTRODUCTION : Driving Forces for SoC- Components - Generic template- Design flow- Hardware/Software nature- Design Trade-Offs-Major Applications-SYSTEM-LEVEL DESIGN: Processor selection-Concepts in Processor Architecture: Instruction set architecture (ISA) -Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC—Processor evolution: Soft and Firm processors, Custom-Designed processors-IP based design- on-chip memory (10)

SYSTEM-LEVEL INTERCONNECTION : On-chip Buses: basic architecture, topologies, arbitration and protocols, Bus standards: AMBA, CoreConnect, Wishbone, Avalon-Network-on-chip: Architecture-topologies-switching strategies- routing algorithms-flow control,quality-of-service-Reconfigurability in communication architectures (9)

CO-DESIGN CONCEPTS : Nature of hardware & software- quest for energy efficiency- driving factors for hardware- software codesign- Codesign space-Dualism of Hardware design and Software design-Modeling Abstraction Level-Concurrency and Parallelism- Hardware Software tradeoffs- Introducing Dataflow modelling (9)

SOC IMPLEMENTATION : Study of Microblaze RISC processor - Real-time operating system (RTOS), peripheral interface and components, High-density FPGAs-Introduction to tools used for SOC design: Xilinx SoC based development kit (12)

SOC TESTING : Manufacturing test of SoC: Core layer, system layer, application layer-P1500 Wrapper Standardization-SoC Test Automation (STAT) (5)

Total L: 45

TEXT BOOKS:

- 1.Michael J.Flynn, Wayne Luk , "Computer system Design: System-on-Chip", Wiley-India, 2012.
- 2.Sudeep Pasricha, Nikil Dutt , "On Chip Communication Architectures: System on Chip Interconnect", Morgan Kaufmann Publishers, 2008.

REFERENCES:

- 1.W.H.Wolf , "Computers as Components: Principles of Embedded Computing System Design", Elsevier, 2008.
- 2.Patrick Schaumont , "A Practical Introduction to Hardware/Software Co-design", 2nd Edition, Springer, 2012.
- 3.Lin, Youn-Long Steve , "Essential issues in SOC design: designing complex systems-on-chip", Springer, 2006.

19L025 DIGITAL SIGNAL PROCESSING SYSTEM DESIGN

3 0 0 3

COMPUTATIONAL ACCURACY IN DSP IMPLEMENTATIONS : Number Formats for Signals and Coefficients in DSP systems: Fixed Point Format, Double Precision Fixed Point Format, Floating Point Format, Block Floating Point Format. Dynamic Range and Precision - Sources of Error in DSP Implementations - A/D Conversion Errors – DSP Computational Errors - D/A Conversion Errors. (9)

ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES : Basic Architectural Features-DSP Computational Building Blocks: Hardware Multiplier, Barrel Shifter, MAC Unit-Bus Architecture and Memory-Data Addressing Capabilities- Address Generation Unit- Speed Issues: Hardware Architecture - Parallelism – Pipelining – System level Parallelism and Pipelining-Architecture of TMS320C6748 Processors. (9)

DEVELOPMENT TOOLS FOR DSP IMPLEMENTATIONS : Introduction to Code Composer Studio (CCS) – DSP Software Development using CCS- Implementation of Basic DSP Algorithms: Q-notation, Convolution, FIR Filters, IIR Filters , Decimation Filters, PID Controller, Adaptive Filters –2D Signal Processing: Matrix Multiplication (9)

IMPLEMENTATION OF FFT ALGORITHMS : FFT Algorithm for DFT Computation- Butterfly Computation – Overflow & Scaling – Bit Reversed Index Generation-8-point FFT Implementation on DSP processor- Computation of the Signal Spectrum (9)

INTERFACING SERIAL CONVERTERS TO A PROGRAMMABLE DSP DEVICE : Synchronous Serial Interface- Multichannel Buffered Serial Port (McBSP)-McBSP Programming-CODEC Interface-CODEC Programming- CODEC, DSP Interface. (9)

Total L: 45

TEXT BOOKS:

1. Julien Osmalskyj, Jean-Jacques Embrechts , "Digital Signal Processing Application on the Texas Instrument C6748 Processor", Texas Instruments, 2014.
2. John G Proakis, Dimitris G Manolakis , "Digital Signal Processing", Prentice Hall India, 2013.

REFERENCES:

1. Venkataramani B, Bhaskar M , "Digital Signal Processors: Architecture, Programming & Applications", Tata McGraw Hill, 2015.
2. TI , "Technical Reference Manuals for TMS320C6748", Texas Instruments, 2016.
3. Oppenheim A V , "Discrete Time Signal Processing", Prentice Hall India, 2014.
4. Mitra S K , "Digital Signal Processing – A Computer based Approach", Tata McGraw Hill, 2013.

19L026 VEHICULAR SYSTEMS AND NETWORKS

3 0 0 3

BODY AND CONVINIENCE ELECTRONICS : Electronics in automotive , central body control module system - Lighting and Indicators - external lights, head light reflectors, lighting circuits - Gas discharge and LED lighting - Advanced lighting technology, new developments - Body electrical and electronics systems - washers, wipers, horns - Obstacle avoidance - Cruise control, seats, mirrors - Passenger compartment climate control - Ac unit design and operation - Climate control systems - Comfort and convenience system in door and roof (12)

VEHICLE SAFETY SYSTEMS : Basic security - Top of the range security - Security coded ECU - Air bags and belt tensioners - Other security and control systems - Obstacle avoidance RADAR - Tire Pressure warning - Noise control - (6)

POWER TRAIN SYSTEM : Engine Management system - Combined ignition and fuel management – Exhaust emission control for diesel emissions - complete vehicle control system - Electric vehicles - Hybrid vehicles - - (9)

AUTOMOTIVE NETWORKING : Bus systems - Technical principles - Buses for motor vehicles : CAN, FLEXRAY, LIN, MOST, ETHERNET, PS15 - Introduction to AUTOSAR (8)

VEHICULAR ADHOC NETWORKS : Special Characteristics , Technical Challenges - DSRC spectrum and applications for VANET - IEEE Standards for MAC Protocols - CLuster based and Distributed MAC Protocols - Requirements for routing protocols and classifications - Network Mobility problems - NEMO basic support protocol (10)

Total L: 45

TEXT BOOKS:

1. Tom Denton , "Automobile Electrical and Electronic Systems", 3rd Edition, Routledge Taylor and Francis Group, New york, 2000.
2. Bosch , "Automotive Handbook", 8th Edition, Wiley Eastern, Germany, 2011.

REFERENCES:

1. Nicholas Navet , Francois Simonot-Lion , "Automotive Embedded Systems Handbook", New York 2009, 2009.
2. Dominique Paret , "Multiplexed Networks for Embedded Systems CAN, LIN, FlexRay, Safe", England, 2008.
3. Tom Denton , "Automobile Mechanical and Electrical systems", 2nd Edition, Routledge Taylor and Francis Group, New york, 2018.

19L027 ADVANCED PROCESSOR ARCHITECTURES

3 0 0 3

PARALLEL PROCESSING, MEMORY AND INPUT-OUTPUT SUBSYSTEMS : Trends towards Parallel Processing - Parallel Computer Structures - Architectural Classification Schemes - Parallel Processing Applications. Hierarchical Memory Structure - Virtual Memory System - Cache Memories - Input-Output Subsystems (9)

PRINCIPLES OF PIPELINING AND VECTOR PROCESSING : Principles of Linear Pipelining- Classification of Pipeline Processors-General Pipelines and Reservation Tables- Interleaved Memory Organizations- Principles of Designing Pipelined Processors- Characteristics of Vector Processing-Pipelined Vector Processing Methods - Architecture of Cray-I Vector Processor. (9)

STRUCTURES AND ALGORITHMS FOR ARRAY PROCESSORS : SIMD Array Processors: SIMD Computer Organization - Making the data routing mechanism. SIMD Interconnection Networks: Static Vs Dynamic Networks - Mesh-Connected Illiac Network - Cube Interconnection Networks - Barrel Shifter and Data Manipulator- Parallel Algorithms for Array Processors: SIMD Matrix Multiplication - Parallel Storing on Array Processors and SIMD Fast Fourier Transform (9)

MULTIPROCESSOR ARCHITECTURE, PROGRAMMING, CONTROL AND ALGORITHMS: Loosely Coupled Multiprocessors-Tightly Coupled Multiprocessors-Processor Characteristics for Multiprocessing. Interconnection Networks: Time shared or Common Buses- Crossbar Switch and Multiport Memories-Inter-process Communication Mechanisms: Process Synchronization Mechanisms - Synchronization with Semaphores - Conditional Critical Sections and Monitors. System Deadlocks and Protection: System Deadlocks and Protection - Deadlock Prevention and Avoidance- Deadlock Detection and Recovery and Protection Schemes. (9)

MSP430 MICROCONTROLLER AND TMS320C6713 DSP PROCESSOR : Introduction- - MSP 430 Architecture - Features - Digital I/O : Input Registers - Output Registers - Direction Registers - Pull Up and Pull down Enable Registers Function Select Registers - Configuring Unused Port Pins Digital I/O Registers -TMS320C6000 family overview- Typical Applications - TMS320C67x DSP features and Options - Architecture - CPU-CPU Data Paths - Functional Units - On-chip Peripherals: DMA - EDMA - HPI - McBSP and Timers. (9)

Total L: 45

TEXT BOOKS:

- 1.Venkataramani B, Bhaskar M , "Digital Signal Processors: Architecture, Programming & Applications", Tata McGraw Hill Publishing Company Ltd., 2010.
- 2.TI Team , "MSP430X2xx Family User's Guide", Texas Instruments, .

REFERENCES:

1. Kai Hwang , Faye A Briggs , "Computer Architecture and Parallel Processing", New York, 1985.

19L028 REAL TIME SYSTEMS

3 0 0 3

INTRODUCTION : Basic Real-Time system concepts – Characteristics of Real-Time systems – Design challenges Examples (5)

SOFTWARE REQUIREMENTS ENGINEERING : Requirements Engineering process – Types of requirements – Requirements Specification – Formats methods in Software specification – Structural Analysis and Design – Object-Oriented Analysis and Unified Modeling Language – Requirements Validation and Review (10)

HARDWARE AND SOFTWARE SYSTEM DESIGN : Basic Architecture – Hardware interfacing – CPU – Memory – Input/Output – Enhancing performance – Other special devices. Properties of Software – Basic Software Engineering principles – Design Activity – Procedure-Oriented Design – Object-Oriented Design (13)

REAL-TIME OPERATING SYSTEMS : Real-Time kernels – Foundations of RTOS – Intertask communication and synchronization – Memory management (8)

PERFORM ANALYSIS AND OPTIMIZATION : Performance Analysis – I/O Performance – Performance Optimization Results of Compiler Optimization – Analysis of Memory Requirements – Reducing Memory Utilization (9)

Total L: 45

TEXT BOOKS:

- 1.Krishna C M, Kang G Shin , "Real-Time System", 1st Edition, Tata McGraw Hill, New Delhi, 2017.
- 2.Philip A. Laplante , "Real Time Systems Design and Analysis-An Engineers Handbook", 3rd Edition, IEEE Computer Society Press, 2008.

REFERENCES:

- 1.PRASAD K V K K , "Embedded/Real-Time Systems: Concepts, Design and Programming BLACK BOOK", 1st Edition,

Dreamtech Press, New Delhi, 2015.
2.Herman Kopetz , "Real-Time Systems", Springer, New York, 2011.

19L029 ADVANCED COMPUTER ARCHITECTURE AND PARALLEL PROCESSING

3 0 0 3

INTRODUCTION TO PARALLEL PROCESSING : Evolution of computer systems. Generation of computer systems – Trends towards parallel processing- Parallel processing mechanisms- parallel computer structure- Architectural classification schemes – Application (8)

MEMORY AND I/O SUBSYSTEMS, PIPELINING : Hierarchical Memory structure – Virtual memory system - cache memory management- Memory allocation and management – I/O subsystems pipelining: Principles - Classification of pipeline processors - Reservation tables – Interleaved memory organization – Design of arithmetic pipeline – Design of instruction pipeline. (10)

VECTOR AND ARRAY PROCESSING : Need – Basic vector processing architecture - Issues in vector processing – Vectorization and optimization methods. Array processing: SIMD Array processors – SIMD interconnection networks – Parallel algorithms for array processors – associative array processing (9)

MULTIPROCESSOR ARCHITECTURE : Functional structures - Interconnection network – Multi cache problems and solutions – Exploiting concurrency for multiprocessing (9)

PRINCIPLES OF PARALLEL ALGORITHM DESIGN : Design approaches-Design issues-Performance measures and analysis-Complexities-Anomalies in parallel algorithms - Pseudo code conventions for parallel algorithms- Comparison of SIMD and MIMD algorithms. (9)

Total L: 45

TEXT BOOKS:

- 1.Kai Hwang, Naresh Jotwani , "Advanced Computer Architecture - Parallelism, Scalability, Programmability", Tata McGraw Hill, 2011.
- 2.John L Hennessy , "Computer Architecture a Quantitative Approach", Fifth Edition, Morgan Kaufmann, 2011.
- 3.Seyed Roosta , "Parallel Processing and Parallel Algorithms", Springer Series, 2000.

19L030 EMBEDDED LINUX

3 0 0 3

INTRODUCTION : Embedded Linux - Real Time Linux - Types of Embedded Linux - Reason for choosing Linux - Design and Implementation methodology - Types of Host/Target Development setup - Types of hosts/Target Debug setup (9)

ARCHITECTURE OF EMBEDDED LINUX : Generic architecture of an Embedded Linux System - System Startup - Types of Boot configuration - Selecting the kernel - Configuring the kernel - Compiling the kernel - Installing the kernel. (9)

DEVELOPMENT TOOLS : GNU Cross-platform development tool chain - debugging - tracing & profiling tools - binary utilities - kernel debugging - debugging in Embedded Linux applications (9)

REAL-TIME LINUX : Real-Time Operating System - Interrupt latency - ISR duration - Scheduler latency - Scheduler duration - User space Real Time - Real-Time programming in Linux (9)

PORTING APPLICATIONS : Introduction to Beagle bone - Porting of Embedded Linux prebuilt images - Bone script (9)

Total L: 45

TEXT BOOKS:

- 1.Karim Yaghmour, Jon Masters, Gilad Ben-Yossef , "Building Embedded Linux Systems", 2nd Edition, Shroff Publishers and Distributors, Mumbai, 2014.
- 2.P. Raghavan, Amol Lad , Sriram Neelak , " Embedded Linux System Design and Development", Auerbach Publications, 2019.

REFERENCES:

- 1.Christopher Hallinan , "Embedded Linux Primer", 2nd Edition, Prentice Hall, 2011.
- 2.Derek Molloy , "Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux", Second, John Wiley & Sons, Indiana, 2019.

19L031 OPERATING SYSTEMS

3 0 0 3

INTRODUCTION : Operating system - Functions - Evolution of Operating Systems - Structure of operating system -

Monolithic and Micro Kernel structures. - Linux Architecture - Kernel - Shell Programming (8)

PROCESS MANAGEMENT : Introduction to processes - Scheduling objectives - Scheduling Criteria - Types of scheduling algorithms - Performance comparison - Inter-process communications - Synchronization - Semaphores - Deadlock - Prevention, Recovery, Detection and Avoidance - Classical problems in concurrency - Threads, Thread models - Multithreading. (14)

MEMORY MANAGEMENT : Introduction - Contiguous allocation - Buddy System - Paging - Structure of Page Table - Swapping - Segmentation - Segmentation with paging - Virtual Memory concepts - Demand Paging - Page Replacement Algorithms (8)

FILE MANAGEMENT : File Systems - Files - Directories - File System Implementation - Allocation methods - Free Space management - Security - Protection mechanisms. - Disk structure - Disk Scheduling Algorithms - RAID Levels (8)

LINUX : Process Management - Memory Management - File Systems - Input and Output - Inter-process Communication - Network Structure - Security (7)

Total L: 45

TEXT BOOKS:

- 1.Silberschatz A, Galvin P , Gagne G , "Operating System Concepts", 9th Edition, John Wiley & Sons, Singapore, 2018.
- 2.William Stallings, "Operating Systems: Internals and Design Principles", 9th Edition, Pearson, New Delhi, 2019.

REFERENCES:

- 1.Ann McIver McHoes, Ida M Flynn , "Understanding Operating Systems", Cengage Learning India Pvt Ltd, USA, 2017.
- 2.Mukesh Singhal, Niranjana G Shivaratis , "Advanced Concepts in Operating Systems", 0th Edition, McGraw-Hill Education (I) P Limited, Chennai, 2016.
- 3.Harvey M Deitel, Paul J Deitel, David R Choffness , "Operating Systems", 3rd Edition, Pearson Education, Chennai, 2013.

19L032 RELATIONAL DATABASE MANAGEMENT SYSTEMS

3 0 0 3

BASIC CONCEPTS : Introduction to databases – Characteristics of database approach – Advantages of using DBMS – Database concept and architecture – Data Abstraction – Data Models – Instances and Schema – Data Independence – Schema Architecture – The Database System Environment: Components of a DBMS – Database Languages – Database Administrator – Database Users (8)

DATA MODELING : Introduction – Conceptual modeling: Entities, attributes, relationships –associations- roles and structural constraints – Weak and Strong entity types – Design of Entity Relationship data models (ERD) – Enhanced ER model: Specialization and Generalization – constraints-Aggregation — Applications (9)

RELATIONAL MODEL : Introduction to Relational Data Model – Basic concepts – Enforcing data Integrity constraints – Relational Algebra: Unary Relational Operations, Set theory Operations – Binary relational operations-additional operations- Queries using relational algebra. FILE ORGANIZATION: Storage device characteristics – Operations on file – Serial files – Sequential files – Index sequential files – Direct files – Indexing (8)

SQL PROGRAMMING : Introduction to Structured Query Language (SQL) – datatypes- Data definition Language- , Constructing database, Manipulations on database – Basic data retrieval operations – Advanced Queries in SQL – Functions in SQL – Aggregation – Categorization – Updates in SQL – Views in SQL (10)

DATA BASE DESIGN THEORY : Data base design process – Relational Database Design – Relation Schema – Anomalies in a database – Functional dependencies – Axioms – Normal forms based on primary keys – Second Normal form, Third Normal form, Boyce – Codd Normal form – Examples – Conversion of ERD into tables. DATABASE SECURITY, INTEGRITY CONTROL: Security and Integrity threats – Defense mechanisms – Transaction and concurrency control mechanisms (10)

Total L: 45

TEXT BOOKS:

- 1.Silberschatz A, Korth H , Sudarshan S , "Database System Concepts", 6th Edition, Tata McGraw Hill, 2013.
- 2.Elmasri R , Navathe S B , "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2016.

REFERENCES:

- 1.Date C J, Kannan A, Swamynathan S , "An Introduction to Database Systems", 8th Edition, Pearson Education, 2006.
- 2.Raghu Ramakrishnan , Johannes Gehrke , "Database Management System", 3rd Edition, Tata McGraw Hill, 2007.
- 3.Bob Bryla, Kevin Loney , "Oracle 12c: The Complete Reference", Oracle press, 2014.

19L033 SOFT COMPUTING TECHNIQUES

3 0 0 3

INTRODUCTION : Neural Network Architectures, Characteristics, Learning methods. Basic models -applications. Fuzzy logic:

Introduction -crisp sets-fuzzy sets -crisp relations and fuzzy relations: cartesian product of relation - classical relation, fuzzy relations, tolerance and equivalence. Genetic algorithm-Introduction -biological background -traditional optimization and search techniques -Genetic basic concepts (9)

NEURAL NETWORKS : McCulloch-Pitts neuron -linear separability -hebb network -supervised learning network: perceptron networks -adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN-associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, Kohonen self organizing feature maps (9)

FUZZY SYSTEMS : Membership functions: features, fuzzification, methods of membership value assignments- Defuzzification: lambda cuts -methods -fuzzy arithmetic and fuzzy measures: fuzzy arithmetic -extension principle - fuzzy measures -measures of fuzziness -fuzzy integrals -fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making. (10)

GENETIC ALGORITHMS : Search space -general genetic algorithm –operators -Generational cycle -stopping condition – constraints -classification -genetic programming –multilevel optimization –real life problem-advances in GA (8)

HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS : Neuro-fuzzy hybrid systems -genetic neuro hybrid systems - genetic fuzzy hybrid, fuzzy genetic hybrid systems -simplified fuzzy ARTMAP -Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers (9)

Total L: 45

TEXT BOOKS:

1. Timothy J Ross , "Fuzzy Logic with Engineering Applications", UK, 2010.
2. Sivanandam S N, Deepa S , "Principles of Soft Computing", 3rd Edition, Wiley India Pvt Ltd, 2018.

REFERENCES:

1. Rajasekaran S , Vijayalakshmi Pai G A , "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", 2nd Edition, Prentice Hall of India , 2017.
2. Jang J.S.R, Sun C T, Mizutani E , "Neuro-Fuzzy and Soft computing", Prentice Hall, New Jersey, 2004.
3. Laurene V Fausett , "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Prentice Hall, 2008.

19L034 SOFTWARE DEFINED NETWORKING

3 0 0 3

EVOLUTION AND SOFTWARE DEFINED NETWORKING (SDN) CHARACTERISTICS : Introduction – Centralized/Distributed Control and Data Planes – Fundamental Characteristics of SDN - SDN Operation, Devices Network Virtualization: Concepts, Applications, Existing Network Virtualization Frameworks (9)

SDN IMPLEMENTATION AND OPENFLOW : SDN design - Separation of the control and data planes - Edge- oriented networking - Telecommunication SDN attributes – Telecommunication services – Realisation of SDN using software – OpenFlow: Overview, Channel, Controller Modes, Configuration and management protocol (9)

SDN CONTROLLERS : Introduction - General Concepts – Different controllers: NOX, POX, Ryu, Trema, Floodlight and OpenDaylight - Realisation of Controllers using software (9)

SDN DEVELOPMENT : Existing network limitations - Programmable networks – Network and application information - Legacy to SDN – Protocols in the context of SDN – Additional SDN Protocol Models - Additional SDN Controller Models - Additional Application Models (9)

SDN APPLICATIONS AND OTHER ENVIRONMENTS : Application Types: Reactive and Proactive applications, Internal and External applications - Wide Area Networks - Service Provider and Carrier Networks – Campus Networks - Mobile Networks - Optical Networks (9)

Total L: 45

TEXT BOOKS:

1. Patricia A. Morreale, James M. Anderson , "Software Defined Networking: Design and Deployment", 1st Edition, CRC Press, 2014.
2. Paul Goransson, Chuck Black, Timothy Culver , "Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann, 2016.

REFERENCES:

1. Rajesh Kumar , "Software Defined Networking – a definitive guide", Smashwords Edition, 2013.
2. Thomas D. Nadeau, Ken Gray , "SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies", 1st Edition, O'Reilly Media, 2013.

19L035 COMPUTER AND MACHINE VISION

3 0 0 3

INTRODUCTION : Embedded system overview and applications - features and architecture considerations-ROM - RAM - timers - data and address bus - Memory and I/O interfacing concepts - memory mapped I/O. CISC Vs RISC design philosophy - Von-Neumann Vs Harvard architecture - instruction set - instruction formats - and various addressing modes. Fixed point and floating point arithmetic operations. (6)

BASIC EMBEDDED PROGRAMMING TECHNIQUES : Introduction to TIVAARM Cortex M4 - Key Features - Functional Block Diagram - Pin Configuration - I/O pin multiplexing - pull up/down registers - GPIO control - Memory Mapped Peripherals - programming System registers - Watchdog Timer - need of low power for embedded systems - System Clocks and control - Hibernation Module on Tiva - Active vs Standby current consumption. Introduction to Interrupts - Interrupt vector table - interrupt programming. (11)

TIMERS, PWM AND MIXED SIGNAL PROCESSING : Timer - Basic Timer - Real Time Clock (RTC) - Timing generation and measurements - Analog interfacing and data acquisition: ADC - Analog Comparators - DMA - Motion Control Peripherals: PWM Module & Quadrature Encoder Interface (QEI). (11)

HARDWARE/SOFTWARE INTEGRATION : Host and Target Machines. In-System Programming (ISP)-In-Application Programming (IAP)-Getting Embedded Software into Target System: Programmers. Display - Keyboard - Relay - Stepper and DC Motor Interfacing. (9)

REAL TIME OPERATING SYSTEMS : Survey of Software Architectures - Tasks and Task States - Tasks and Data - Semaphores and Shared Data - Message Queues - Mailboxes and Pipes - Timer functions - Events - Memory Management and Interrupt Routines in RTOS Environment. Study of embedded product design with real time concepts using RTOS (8)

Total L: 45

TEXT BOOKS:

1. Jonathan W Valvano , "Introduction to Arm Cortex -M Microcontrollers", 2012.
2. David E Simon , "An Embedded Software Primer", Pearson Education Asia, 2009.

REFERENCES:

1. Rajkamal , "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill, 2008.
2. Andrew Sloss & Dominic Symes & Chris Wright , "ARM System Developer's Guide, 1st Edition, Elsevier, Morgan Kaufmann Publishers 2004.", 2004.

19L036 DIGITAL COMMUNICATION RECEIVERS

3 0 0 3

BASEBAND COMMUNICATION : Baseband PAM, Clock Synchronizers - Error tracking and spectral line generating synchronizers, Squaring synchronizers, Mueller and Muller synchronizers (9)

PASSBAND COMMUNICATION : Passband Transmission, Receivers for PAM, Sufficient Statistics for Reception in Gaussian Noise, Optimum ML receivers - Synchronized detection, Digital matched filter (9)

SYNCHRONIZATION ALGORITHMS : ML synchronization algorithms – Estimator Structures for Slowly Varying Synchronization Parameters, Non-Data Aided and Data Aided algorithms. Timing parameter and carrier phase estimation, Phase Locked Loop (9)

PERFORMANCE ANALYSIS OF SYNCHRONIZERS : Tracking Performance of Carrier and Symbol Synchronizers, Feedback and feed forward synchronizers. Cycle slipping, Acquisition of carrier phase and symbol timing (9)

RECEIVERS FOR FADING CHANNELS : Characterization of Fading channels, Detection and parameter synchronization on Fading channels, Receiver structures for fading channels – Outer and Inner receivers, parameter synchronization for flat fading and selective fading channels (9)

Total L: 45

TEXT BOOKS:

1. H. Meyer, M. Moeneclaey, S. A. Fechtel , "Digital Communication Receivers", Wiley, 2015.
2. U. Mengali, A.N.D. Andrea , "Synchronization Techniques for Digital Receivers", Kluwer, 2014.

REFERENCES:

1. Proakis J G, Salehi M , "Digital communications", Tata McGraw Hill, New York, 2018.
2. Rohde U L, Whitaker J C, Zahnd H , "Communications Receivers", McGraw-Hill, 2017.
3. Bernard Sklar , "Digital Communications- Fundamentals and applications", Prentice Hall, 2017.
4. Lathi B P , "Modern Digital and Analog communication Systems", Oxford University Press, 2017.

19L037 EMC TEST AND MEASUREMENTS

3 0 0 3

NATURE AND ORIGINS OF ELECTROMAGNETIC COMPATIBILITY : Introduction – Visualising the EMI problem - Source of EMI – EMI coupling to victim equipments - Intersystem and Intrasystem EMI – Historical background - Technical disciplines and Knowledge areas within EMC - Electrical engineering – Physics –Mathematical modeling – Limited chemical knowledge – - System engineering – Legal aspects of EMC. (9)

EMC STANDARDS AND SPECIFICATIONS : The need for standards and specifications – The need to meet EMC standards - Derivation of military standards – Derivation of commercial standards– - Outline of EMC testing - Types of EMC testing – Preconformance test measurements - Implication of repeatability of EMC measurements - Introduction to EMC test sensor - Conduction and Induction couplers – Radiative coupling - EMC antennas. (9)

MEASUREMENT DEVICES FOR CONDUCTED EMI : Introduction – Measurement by direct connection - Inductively coupled devices - EMC antennas – Basic antenna parameters - Antennas for radiated emission testing – Wideband antennas - Magnetic field antennas – Use of antennas for radiated susceptibility testing - Type of antennas used in susceptibility testing – Standards requiring immunity tests (9)

RECEIVERS, ANALYSERS AND MEASUREMENT EQUIPMENT : EMI receiver - Spectrum Analyzers - RF power meter Frequency meters - Instrumentation for susceptibility testing – Automatic EMC tests - Electromagnetic transient testing – Transient types – Continuous and transient signal – - ESD-electrostatic discharge (9)

DESIGNING TO AVOID EMC PROBLEMS : Intrasystem and Intrasystem EMC – - Design for formal EMC compliance Achieving product EMC :checklists for product development and testing - Introduction – Developing an approach to EMC design - Process flow chart, - EMC strategy – Self certification. (9)

Total L: 45

TEXT BOOKS:

- 1.David Morgan , "A Handbook for EMC Testing and Measurement", IET Electrical Measurement, 2012.
- 2.Tim Williams , "EMC for Product Designers", 5th Edition, Newnes Elsevier, 2017.

REFERENCES:

1. Clayton R. Paul , "Introduction to Electromagnetic Compatibility", Wiley Press, 2014.

19L038 DEEP LEARNING

3 0 0 3

INTRODUCTION : Motivation for deep learning - Machine learning Basics: Learning algorithms - Overfitting - Underfitting - Hyper parameters Estimators - Validation - Maximum Likelihood estimation - Bayesian Statistics - Challenges in Machine Learning (6)

DEEP LEARNING NETWORKS : Gradient based learning - Hidden Units - Architectural design - Back - propagation for MLP - Regularization - Parameter Regularization - Data Augmentation - Dropout - Optimization algorithms - Adaptive learning rates (8)

CONVOLUTIONAL NEURAL NETWORK : Architecture - Pooling - Convolution and its variants - CNN for Image Recognition (9)

SEQUENCE MODELING : Recurrent Neural Networks(RNN) - Bi - directional RNN, Encoder Decoder Architecture - Recursive Nets - LSTM - Gated RNN - RNN for Sentiment Analysis (11)

DEEP LEARNING MODELS : Autoencoders - Deep Boltzmann Machine - Deep Belief Networks - Architecture - Greedy Learning – Speech Processing and Recognition using DBN (11)

Total L: 45

TEXT BOOKS:

- 1.Ian Goodfellow, YoshuaBengio, Aaron Courville , "Deep Learning", MIT Press, USA, 2016.
- 2.Adam Gibson, Josh Patterson , "Deep Learning A practitioner's approach", O'Reilly, USA, 2016.

REFERENCES:

- 1.Yusuke Sugomori , "Deep Learning: Practical Neural Networks with Java", Packt Publisher, New York, 2016.
- 2.Jeff Heaton , "Artificial Intelligence for Humans: Deep Learning and Neural Networks", Lightning Source Inc, Tennessee, 2015.

LANGUAGE ELECTIVES

19G001 COMMUNICATION SKILLS FOR ENGINEERS

0 0 4 2

COMMUNICATION CONCEPTS :

Process of Communication
Inter and Intrapersonal Communication
Inter and Intrapersonal Communication Activities (9)

FOCUS ON SOFT SKILLS :

Etiquette — Work Place etiquette — Telephone etiquette
Body Language
Persuasive Communication
Public Speaking
Critical Reasoning and Conflict Management based on Case Studies
Group Communication
Meetings
Interview Techniques (14)

TECHNICAL WRITING :

Technical Writing Principles
Style and Mechanics
Technical Definitions – Physical, Functional and Process Descriptions
Technical Report Writing
Preparing Instructions and Manuals
Interpretation of Technical Data (15)

BUSINESS CORRESPONDENCE :

Writing Emails
Preparing Resumes
Memos
Technical and Business Proposals (7)

TECHNICAL COMMUNICATION :

Seminars
Process Description and Group Discussions
Use of Visual Aids (15)

Total P: 60

TEXT BOOKS:

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

19G002 GERMAN- LEVEL A1.1

0 0 4 2

GUTEN TAG! :

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W — Questions, Verbs & Personal pronouns I. (10)

FREUNDE, KOLLEGEN UND ICH :

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural (10)

IN DER STADT :

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs (12)

GUTEN APPETIT! :

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs (13)

TAG FÜR TAG/ZEIT MIT FREUNDEN :

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments on phone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs (15)

Total P: 60**TEXT BOOKS:**

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt GmbH., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

REFERENCES:

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt GmbH., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

19G003 FRENCH LANGUAGE LEVEL 1**0 0 4 2****PARTS OF SPEECH :**

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs
4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes (12)

ELEMENTS OF GRAMMAR :

1. Exprimer l'ordre et l'obligation demander et commander
2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions (12)

SENTENCE STRUCTURE :

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait (12)

TENSES AND NUMBERS :

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport (12)

DISCOURSE :

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information (12)

Total P: 60**TEXT BOOKS:**

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

REFERENCES:

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", ..
3. Simone Renaud, Dominique van Hooff "En bonne forme", ..

19G004 BASIC JAPANESE

0 0 4 2

JAPANESE PEOPLE AND CULTURE :

1. Basic greetings and responses
2. Basic script— Method of writing hiragana and katakana — Combination sounds and simple words
3. Selfintroductions: "Hajimemashite"-Demonstratives "Kore", "Sore", "Are"— Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no"— Japanese apartments: Greeting your neighbor (12)

PATICLE "NI (AT)" FOR TIME :

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day —Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e". (12)

LIKES AND DISLIKES :

1. Potential verbs (wakarimasu and dekimasu) — "Kara (~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? (~ mashou ka) — Describing a natural phenomenon (It is raining) (12)

DIFFERENT USAGES OF ADJECTIVES :

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage) (12)

ROLE PLAYS IN JAPANESE :

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party (12)

Total P: 60

TEXT BOOKS:

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo,2012

REFERENCES:

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", ., 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", ., 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary", .,

ONE-CREDIT COURSES

19LF01 LINUX AND SCRIPTING LANGUAGES

1 0 0 1

INTRODUCTION TO LINUX : The Linux Shell Environment – Files and Directories – Entering Commands on Linux Systems – Command Options and Arguments – Customizing Environment – Linux Features (2)

EDITOR : Text editing with vi editor – Starting vi – Different Modes of Operation – Advanced Editing with vi (2)

THE SHELL : : The Common Shells – Necessity of the Shells – Wildcards Usage – Standard Input and Output - Shell Variables – Command Substitution – Running Commands in the Background – Job control (3)

SHELL PROGRAMMING : Shell Scripts – Providing Arguments to Shell Programs – Shell Output and Input – Conditional Execution – Looping – Command Line Options in Shell Scripts – Arithmetic Operations – Debugging Shell Programs (3)

PERL : Basic Perl Concepts – File handles – Scalar Variables – Arrays and Lists – Pattern Matching and Regular Expressions – Trouble shooting Perl Scripts (3)

TCL : Basic Tcl Concepts – Features – Programs (2)

Total L: 15

TEXT BOOKS:

1. Douglas Host, Rachel Klee, James Farber and Dick Rosinski, Ken Rosen , "The Complete Reference", McGraw Hill, New York, 2007.
2. John C. Welch, and Micah Anderson, Eric Foster-Jonson , "Shell Scripting", Wiley India Pvt. Ltd, New Delhi, 2008.

19LF02 AVIONICS

1 0 0 1

INTRODUCTION TO FLIGHT-THEORY OF FLIGHT AND CONTROL SURFACES : Brief about Avionics - Evolution of Avionics - Brief about various Avionic systems on board an aircraft - Power supply systems-Electrical Power Sources-Power generation and distribution systems - Navigation Systems-Electrical Navigation Systems- Compasses, Inertial Navigation Systems (INS) (3)

RADIO NAVIGATION SYSTEMS : Automatic Direction Finder (ADF) -Global Positioning System (GPS) -Very High Frequency Omni-Range (VOR)-Instrument Landing System (ILS) -Air Traffic Control System (ATC) -Distance Measuring Equipment (DME) -Ground Proximity Warning System (GPWS)-Traffic Collision Avoidance System (TCAS)- Weather Radar (4)

FLIGHT INSTRUMENTS : Air Data Systems/ Computers (ADS/ADC), Pitot Static Systems-Air Speed Indicator (ASI)- Vertical Speed Indicator (VSI)-Barometric Altimeters-Radio Altimeters-Artificial Horizon or Attitude Indicator-Flight Directors (FD) (3)

POWER PLANT SYSTEMS : Communication systems-VHF, HF, Data-link, Voice scramblers - Automatic Flight Control Systems (AFCS)-Automatic Flight Guidance Systems (AFGS)-Autopilot - Miscellaneous systems-Collision Avoidance Systems (CAS), Flight Data Recorders (FDR), Cockpit Voice Recorders (CVR) - Space avionics- Challenges in design (5)

Total L: 15

TEXT BOOKS:

- 1.E H J Pallett , "Aircraft Instruments and Integrated Systems", First Edition, Avionics Communications, 1992.
- 2.Dr Albert Helfrick , "Principles of Avionics", 8th Edition, Avionics Communications, 2013.
- 3.Ian Moir and Allan Seabridge , "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", 3rd Edition, Wiley, 2011.

19LF03 SYSTEM LEVEL VERIFICATION TECHNIQUES AND METHODOLOGIES

1 0 0 1

SYSTEM VERILOG FOR VERIFICATION : Data types – Function and task - Basic OOP – Class Methods – Handling objects – Public and local variables. (3)

SYSTEM LEVEL VERIFICATION ENVIRONMENT AND COMPONENTS : Basic component in Verification -- Driver – Stimulus generator – Monitor – Scoreboard – Checker -- Creating test bench. (3)

STIMULUS – COVERAGE AND ASSERTIONS : Generating different type of stimulus – Constrained Random Stimulus generation – Directed stimulus Generation -- Coverage Driven Simulation – Assertion based Simulation. (3)

INTRODUCTION TO OVM : Introduction to OVM - OVM class and its hierarchy – OVM test bench and environment – Basics of Transaction-Level Modeling (TLM) – OVM components – Developing Reusable OVM Components (3)

CASE STUDY : Sample architecture – Creating verification environment– Creating the test plan – Creating test case Reusable - Transaction Level Models - Managing Simulations - Regression. (3)

Total L: 15

TEXT BOOKS:

- 1.Janick Bergeron , "Writing Test Benches Using System Verilog", First Edition, Springer, 2009.
- 2.Mark Glasser , "Open Verification Methodology Cookbook", Springer, 2009.
- 3.Chris Spear, Greg Tumbush , "System Verilog for Verification - A Guide to Learning the Testbench Language Features", Third Edition, Springer, 2012.
- 4.Andreas Meyer , "Principles of Functional Verification", Newnes, 2003.

19LF04 ADVANCED AVIONICS

1 0 0 1

LAYOUT OF A CONVENTIONAL COCKPIT AND DISADVANTAGES : Configuration of a typical Integrated Avionics Systems-Glass Cockpit Systems-Flight Management Systems (FMS)-Electronic Flight Instrument System (EFIS) - Units of EFIS-EFIS units signal interfacing (with block diagram)-Functions of each unit-Display system-Symbol Generator and Card Interfacing-Control Panel-Electronic Attitude Director Indicator (EADI)-Electronic Horizontal Situation Indicator (EHSI)-Engine Indicating and Crew Alerting System (EICAS)-Explanation of functions of units with functional diagram - Electronic Centralised Aircraft Monitoring System (ECAM) (6)

ADVANCED RADAR SYSTEMS : Helmet Mounted Target Designation System (HMTDS)-Full Authority Digital Engine (or electronics) Control (FADEC)-Avionics of Unmanned Aerial Vehicles (UAV) - All Electric Aircraft-Design of In-flight Entertainment Systems (3)

TACTICAL MISSION SYSTEMS : Concept of a Tactical Mission System-Systems of a typical Tactical Mission System: Radio Sonic System(RSS), Magnetometric Measurement System (MMS), Control Computer System (CCS), Infra-Red Television System (IRTV) (4)

DATA BUSES : Avionics Standard Communications Bus (ASCB), ARINC-429-RS-404, RS 429, MIL-STD-1553 - Space Shuttle Avionics (2)

Total L: 15

TEXT BOOKS:

- 1.RPG Collinson , "Introduction to Avionics Systems", Third Edition, Springer, Jun 2011.
- 2.E H J Pallett , "Aircraft Instruments and Integrated Systems", First Edition, Avionics Communications, 1992.

19LF05 E-COMMERCE SECURITY

1 0 0 1

INTRODUCTION : Introduction to e-Commerce - Infrastructure – Benefits, limitations - Security Threats, Vulnerabilities – Standards-IEEE (3)

SECURITY MECHANISMS : Legal issues – Cyber Crimes - key management and certificates - payment security services - communication network and network access layer security - Internet layer security and transport layer security - application layer security - hypertext transfer protocol - web server security - web client security, mobile code security - mobile agent security - mobile commerce security, digital signature certificates – eCards Security – mobile payment technology –Payment Card Industry Data Security Standard PCI / DSS. (6)

HANDS-ON TRAINING : Modeling and design of a secure Web/Mobile based e-commerce application, securing internal network, and providing secure employee/user authentication. (6)

Total L: 15

TEXT BOOKS:

- 1.Yun Zhao Chwan-Hwa (John) Wu and J. David Irwin , "Introduction to Computer Networks and Cybersecurity", 1st Edition, CRC Press, 2013.
- 2.Anup K, Ghosh , "E-Commerce Security and Privacy", Kluwer Academic Publishers, 2001.
- 3.Ford W Baum M , "Secure Electronic Commerce: Building the Infrastructure for Digital Signatures and Encryption", Prentice Hall, New Delhi, 2001.

19LF06 NANO TECHNOLOGY

1 0 0 1

QUANTUM PHENOMENA : Limitation of classical physics – plank's quantum hypothesis – wave nature of particle – uncertainty principle. (2)

MATERIALS : Free electron and band theory of solids, metals, insulators, semiconductors, semiconductor device concepts. (2)

NANO DEVICE FABRICATION : Overview of nano devices and materials requirement, Physical Vapour deposition, Chemical Vapour Deposition, solgel process, Photolithography, electron beam lithography, imprint lithography, etching. (4)

NANO DEVICES : Nano MOSFET performance metrics, transport in nano MOSFET, Nano actuators, Nano Cantilevers. (3)

NANOCHARACTERIZATION AND SIMULATION TECHNIQUES : Thickness measurement using reflectance and ellipsometry techniques, AFM, FTIR, XRD, SEM, TEM, Simulation techniques and tools. (4)

Total L: 15

TEXT BOOKS:

- 1.Arulhas G , "Quantum Mechanics", PHI Learning Pvt.Ltd, New Delhi, 2011..
- 2.William D Callister, David G. Rethwisch , "Materials Science and Engineering", Wiley Publications, New Jersey, 2010.
- 3.Mick Wilson, Kamali Kannangara, Geoff smith , "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, New Delhi, 2005.
- 4.Rainer Waser , "Nanoelectronics and Information Technology: Advanced Electronic Materials Novel and Devices", Wiley Vch Verlag, Weiheim, 2005.

19LF07 MACHINE VISION ALGORITHMS AND SYSTEM DESIGN

1 0 0 1

INTRODUCTION : Difference between Image processing, Machine Vision and Computer Vision, Applications - Industrial

automation and quality inspection, Tracking, Gesture Recognition, Object detection and recognition, Face detection and recognition, Vision for robot control and 3D Reconstruction. (3)

CAMERA, LENS AND LIGHTING : Pinhole Camera, Image Formation, Projective Geometry, Lenses and Camera System, Various types of Sensors, Lighting methods, Camera Interfaces, Image transfer to a computer, Representation of an image in a computer (3)

IMAGE PROCESSING IN MACHINE VISION : Histogram, Thresholding, Otsu's Method, Adjacency, Morphology, Flood Fill, Connected Component Analysis, Perimeter, Chamfering, Moments, Compactness, Eccentricity, Convolution, Gaussian Pyramid, Edge Detection, Filtering, Segmentation. (3)

BUILDING A MACHINE VISION SYSTEM : System Setup, Pre-processing, Core Algorithm and Post Processing, Ablative Analysis, Cross Validation, ROC Curves, Supervised Learning, Unsupervised Learning, Cutting Edge of Computer Vision. (3)

CASE STUDIES : Design of high speed pencil inspection and sorting system - Design of automated color registration control system for web offset printing machines - Design of high performance counterfeit currency detection system (3)

Total L: 15

REFERENCES:

- 1.Milan Sonka, Vaclav Hlavac, Roger Boyle , "Image Processing, Analysis, and Machine Vision", Cengage Learning, 2014.
- 2.Forsyth D, Ponce J , "Computer Vision: A Modern Approach", Prentice-Hall, 2015.
- 3.Truccho E, Verri A , "Introductory Techniques for 3-D Computer Vision", Prentice-Hall, 2010.
- 4.Szeliski R , "Computer Vision: Algorithms and Applications", Springer Verlag, 2011.

19LF08 ROUTING ARCHITECTURE AND DESIGN

1 0 0 1

OVERVIEW : OSI and TCP/IP Models, explanation of each layer along with real time example, IP Addressing schemes, IPV4 and IPV6 evolution, LAN, WAN, MAN, Networking devices (2)

NETWORKING INFRASTRUCTURES AND DESIGNS : Discovering Network Design Basics, Network design overview, Benefits of hierarchical network design, Network design methodology (3)

ROUTING ARCHITECTURE : Cisco Routers and its types , Types of Routing protocols, Static Routing, Dynamic routing, RIP, OSPF, EIGRP, BGP, Routing Technologies MPLS, L2VPN, L3VPN, IPSEC VPN (4)

NETWORKING PHASES : Planning & Design, Testing and Validation, Implementation and Deployment, Maintenance and change (3)

DEMO : Quick Demo with simulators on building Simple Network Topology -Vlan configurations, Static Routing, Any one routing protocol implementation (3)

Total L: 15

TEXT BOOKS:

1. Kevin Wallace, Raymond Lacoste , "Cisco press, Routing and Switching Route 300 -101 Official Cert Guide", Cisco Press, 2014.

REFERENCES:

1. David Hucaby , "Ccnp Routing and Switching Switch 300 -115 Official Cert Guide", Cisco press.

19LF09 AUTOMOTIVE CONTROLLER AREA NETWORK AND SECURITY

1 0 0 1

INTRODUCTION : Basics of automotive electronic control units and building blocks –exemplary ECU functionality – overview of automotive in vehicular architecture -Security Basics: Security goals–Security threats–Security Mechanisms–Application of security mechanisms in automotive systems (3)

AUTOMOTIVE CAN NETWORKS : Introduction -The CAN Standard-CAN Message--CAN Arbitration –Message Types-A Valid Frame-Error Checking and Fault Confinement -The CAN Bus-CAN Transceiver Features (4)

AUTOMOTIVE DIAGNOSTICS OVER CAN : On Board—Diagnostics –OBD Applications–Diagnostics Scan tool - OBD-II signal protocols–Diagnostics over CAN–Remote Diagnostics and Future trends (4)

AUTOMOTIVE SECURITY VULNERABILITIES : Security Vulnerabilities in vehicular networks -Security Vulnerabilities in Diagnostics networks -Security Vulnerabilities in multimedia systems–Exemplary CAR hack –Possible mitigations and Security measures (4)

Total L: 15

TEXT BOOKS:

1. William Stallings , "Cryptography and network security principles and practice", Prentice Hall of India, 2011.

REFERENCES:

1. Ronald K Jurgen , "Infotainment Systems on Fast Forward", SAE International, 2007.
2. Dennis , "Automotive Telematics: The One -stop Guide to In-vehicle Telematics and Infotainment Technology and Applications", Red Hat Publishing, 2002.

19LF10 UNDERWATER TACTICAL AND COMMUNINATION ENGINEERING**1 0 0 1**

INTRODUCTION : Scope of underwater Tactical and Communication Engineering- Understanding the Ocean - Characteristics of the Medium – Properties of Sound (2)

PRINCIPLES OF UNDERWATER SOUND : The Active and Passive SONAR Equations and their Limitations– Echo, Noise, Reverberation Level and their relationship with Range - Properties of Transducer Arrays - Transducer Calibration Methods - Product Theorem and the Mills Cross -Projector Source Level - Limitations on Sonar Power - Non-Linear Effects in Sonar - Explosions as Sources of Underwater sound. (4)

PROPAGATION OF SOUND : Losses - Absorption of Sound in the Sea - Velocity of Sound in the Sea - Ambient Noise - Scattering in the Sea - Reflection and Scattering by Targets – Detection of Signals in Noise and Reverberation - Design and prediction in Sonar systems (4)

UNDERWATER COMMUNICATIONS : Challenges – Methods of VLF communication – VLF broadcasting – Methods followed worldwide – Low Frequency Analysis and Recording (LOFAR) – Communication systems used on board Submarines. (2)

SUBMARINES : Roles – Design and Construction – Propulsion – Characteristics (1)

SONOBUOYS : Active and Passive Sonobuoys – Functions – Types –Bathymograph (1)

UNDERWATER WEAPONS : Mines – Torpedoes – Rockets – Depth Charges (1)

Total L: 15**REFERENCES:**

1. Robert J Urick , "The Principles of Underwater Sound", 3rd Edition, Peninsula Publishing, Feb 1997.
2. A.D. Waite , "Sonar for Practicing Engineers", 3rd Edition, John Wiley & Sons, Mar 2002.
3. Lufen Xu , "Digital Underwater Acoustic Communications", Academic Press, Sep 2016.
4. Willis J. Abbot , "Aircraft and Submarines-The Story of the Invention, Development, and Present-Day uses of War's Newest Weapons", Kindle, Amazon Asia-Pacific Holdings Private Limited, .

19LF11 EMBEDDED PROCESSING WITH FPGAS**1 0 0 1**

INTRODUCTION : Review – Basics of embedded systems – Types of embedded systems – Microcontroller based, DSP based, PLD based - Introduction to smart systems – Components of smart systems – Need for FPGA's in embedded systems. (2)

FPGA ARCHITECTURES : Evolution of FPGA architecture – FPGA's for embedded systems – Architectural features of FPGA's for embedded systems – Soft and hard processor/controller IPs and features – Memory and I/O macros and its utilization – Layers in FPGA based embedded system. (3)

HDL CODING FOR FPGA : Coding guidelines for combinational and sequential logic circuits – Coding guidelines for memory and FSM in FPGA based designs – Memory modelling in FPGAs – IP based embedded design using FPGAs. (4)

SOC DESIGN FLOW USING FPGAS : Architecture –Bringing up of hardware abstraction layer – Board Support Packages (BSP's) for the target hardware – Developing applications for the target hardware, compilation and simulation of application – Integration of hardware and software components – Debugging the embedded system (4)

CASE STUDY : Real-time applications. (2)

Total L: 15**TEXT BOOKS:**

1. Michael D Ciletti , "Advanced Digital Design with Verilog HDL", Second Edition, Pearson education, 2017.
2. Ming-Bo Lin , "Digital System Designs and Practices: Using Verilog HDL and FPGAs", First Edition, John Wiley, 2016.
3. Rahul Dubey , "Introduction to Embedded System Design Using Field Programmable Gate Arrays", Springer-Verlag London Limited, 2009.
4. Louise H Crockett, Martin A. Enderwitz, Robert W. Stewart, and Ross A. Elliot , "The Zynq Book: Embedded Processing With the ARM® Cortex®A9 on the Xilinx®", Xilinx, 2016.

19LF12 ASIC FLOW FOR MIXED SIGNAL VLSI DESIGN

1 0 0 1

INTRODUCTION : VLSI Design Cycle - Role of CAD Tools in VLSI Design Process (2)

LOGIC DESIGN : Specification - Design Entry - RTL Coding – Schematic based Design - Logic Synthesis – Design Constraints - Synthesis for Low Power, Low Area and High Performance (3)

PHYSICAL DESIGN AUTOMATION : Partitioning –Floor Planning - Placement –Constraint Driven Design Flow – Pin Assignment – Challenges in Mixed Signal Circuit Implementation in a Monolithic Substrate (3)

ROUTING AND TIMING CLOSURE : Grid Routing and Global Routing - Detailed Routing and Clock Design - Clock Routing and Power/Ground Routing–Clock Tree Synthesis – Static Timing Analysis and Timing Closure, PVT Corners – Design for Manufacturability. (3)

PHYSICAL DESIGN SIGN-OFF : Physical Synthesis and Performance Driven Design Flow - Interconnect Modeling and Layout Compaction – Physical Design Verification (DRC, LVS, ERC), IR drop analysis, Electro-Migration Analysis, Cross-Talk (SI) analysis, Sign-off Timing analysis, Logical Equivalence checking – Back Annotation – GDS II Generation - Engineering Change Order – Package - Testing. CASE STUDY: Designs covering Spec to Sign-off. (4)

Total L: 15

TEXT BOOKS:

1. Michael D Ciletti , "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson Education, 2017.
2. Behzad Razavi , "Design of Analog CMOS Integrated Circuits", McGraw-Hill Education, 2016.
3. Andrew B Kahng, Jens Liening, Igor L. Markov and Jin Hu , "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer, 2011.
4. Sherwani N A , "Algorithms for VLSI Physical Design Automation", Kluwer, 2007.
5. Micheli G D , "Synthesis and Optimization of Digital Circuits", Tata McGraw Hill, 2003.

19LF13 DESIGN OF SATELLITE SUB-SYSTEMS AND TELEMETRY

1 0 0 1

INTRODUCTION : Origin of Satellite Communications - Historical Back-ground - Basic Concepts of Satellite Communications - Frequency allocations for Satellite Services & Applications - Future Trends of Satellite Communications (4)

ORBITAL MECHANICS AND LAUNCHERS : Orbital Mechanics - Look Angle determination - Orbital perturbations – Orbit determination - launches and launch vehicles - Orbital effects in communication systems performance (3)

SATELLITE SUBSYSTEMS : Attitude and orbit control system – telemetry – tracking - Command and monitoring – power systems - communication subsystems - satellite antenna - equipment reliability and space qualification (4)

EARTH STATION TECHNOLOGY : Introduction – Transmitters – Receivers – Antennas - Tracking systems – Terrestrial interface - Primary power test methods (4)

Total L: 15

TEXT BOOKS:

1. M. Richharia , "Satellite Communications and Design Principles", 2nd Edition, BS Publications, 2003.
2. D.C Agarwal , "Satellite Communication", 5th Edition, Khanna Publications, 2007.
3. K.N. Raja Rao , "Fundamentals of Satellite Communications", PHI, 2004.

REFERENCES:

1. Dennis Roddy , "Satellite Communications", 2nd Edition, McGraw Hill, 1996.

19LF14 LORA GATEWAY DESIGN & APPLICATION

1 0 0 1

INTRODUCTION TO LORA : Introduction to LoRa –Radio Communication – Frequency Spectrum-Licensed and Unlicensed-Available Wireless Technologies and need for LoRa- Class A, Class B , Class C operation- Radio Propagation. (3)

LORA TRANSCEIVER : Power-Frequency-Bandwidth -AFC- BT product- LoRa Modulation- Chirp Spread Spectrum - Spreading Factor- Window Length -Transmission/Reception time. (3)

LORA GATEWAY CONFIGURATION : MAC Configuration-Channel Number/Frequency- Data Rate Selection- Gateway Parameters- Ip allocation- Up/Down Ports- Polling Rate- Polling Behaviour- Upstream/Downstream Data. (3)

LORA WAN ARCHITECTURE : Server Device Model- Local LoRa Server Port- Create /Update Application Server to Data base- Network Session Key- Application Session Key - Downlink- Queue - Application Testing. (3)

CASE STUDIES : LoRaWAN design Thinking- Microchip- Semtech -mbed -Kerlink-Multitech- gateway-comparison- selection- Use case driven Approach- Road map to Smart City Applications (3)

Total L: 15

REFERENCES:

1.Pradeeka Seneviratne , "Beginning LoRa Radio Networks with Arduino: Build Long Range, Low Power Wireless IoT Networks", Apress, 2019.

19LF15 5G TECHNOLOGY

1 0 0 1

MODELLING & SIMULATION OF END-TO-END COMMUNICATION SYSTEM : Build an end-to-end QPSK model and analyze the system performance (Eye Diagram, Constellation, BER Curve Computation), Modelling RF Front-ends (6)

ANTENNA AND ARRAY DESIGN : Design, analysis, and visualization of antenna elements and arrays using either predefined elements with parameterized geometry or arbitrary planar elements. Gerber generation from design for manufacturing printed circuit board (PCB) antennas (4)

OVER-THE-AIR-TESTING WITH SOFTWARE DEFINED RADIO HARDWARE (SDR) : Introduction to Software Defined Radio, Radio I/O-Streaming with Real-World Signals using RTL-SDR/Adalm Pluto SDR Hardware (3)

MODELLING & SIMULATION OF LTE & 5G WIRELESS COMMUNICATION SYSTEMS : LTE Signal generation & analysis, 5G NR Fundamentals, 5G vs LTE- Main Physical Layer Differences, Applications & Use Cases, 5G NR Simulation .Wireless Technology Development with Model Based Design (Case Study) (2)

Total L: 15

REFERENCES:

1.Michael Rice , "Digital Communications - A Discrete-Time Approach", Prentice Hall, 2008.
2.Dalman, E., S. Parkvall, and J. Sköld , "4G, LTE-Advanced Pro and The Road to 5G", Third, Academic Press, 2016.

HUMANITIES

19OFA1 EXPORT – IMPORT PRACTICES

1 0 0 1

INTRODUCTION : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

EXPORT PROCEDURES : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

FOREIGN EXCHANGE : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

IMPORT PROCEDURES : Import Policy – License - Procedure and Documentation. (3)

EXPORT INCENTIVES : Incentives - Institutional support (2)

Total L: 15

REFERENCES:

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

19OFA2 INSURANCE - CONCEPTS AND PRACTICES

1 0 0 1

INTRODUCTION TO INSURANCE AND RISK MANAGEMENT : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

INSURANCE LAWS AND REGULATIONS : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

INSURANCE UNDERWRITING AND RISK MANAGEMENT : Meaning of underwriting and underwriter, guidelines and steps in

the process of underwriting – characteristics, significance and principles of risk management. (4)

FINANCIAL ASPECTS OF INSURANCE MANAGEMENT : Role and functions of financial institutions, determination of premium for various insurance products. (3)

SETTLEMENT OF INSURANCE CLAIMS : Documents needed during various claims, Factors affecting insurance claims (3)

Total L: 15

REFERENCES:

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

190FA3 PUBLIC FINANCE

1 0 0 1

INTRODUCTION: Nature and Scope of public finance – Principles of taxation. (2)

PUBLIC REVENUE AND TAXATION: Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)

PUBLIC EXPENDITURE: Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)

DEFICIT FINANCING AND BUDGET: Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)

FEDERAL FINANCE: Centre-State financial relations – Finance commissions. (3)

Total L: 15

REFERENCE BOOKS:

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

ENGLISH

19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

1 0 0 1

INTRA ORGANIZATIONAL COMMUNICATION : Communication Networks in an Organization; Intra- organizational communication (2)

INTER ORGANIZATIONAL COMMUNICATION : Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

COMMUNICATION FUNCTIONS IN ORGANIZATIONS : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

WRITTEN COMMUNICATION : Email Writing, Professional Reports, and Memos (4)

INTERPERSONAL SKILLS : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

Total L: 15

REFERENCES:

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

PROSE : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Bertrand Russel (4)

POETRY : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

DRAMA : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

ONE-ACT PLAY : The theme of love in Chekhov's The Bear (3)

SHORT STORY : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

Total L: 15

TEXT BOOKS:

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

REFERENCES:

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.