Tripura University (A Central University)
Suryamaninagar,Tripura 799022, India

M.Tech. (Electronics and Communication Engineering)

Curriculum Structure

Semester I

Course Type	Course Code	Course Name	Marks	L	T	P	Credits
Core 1	EC 901 C	Advanced Optical Fibre Communication System	100	04	0	0	04
Core 2	EC 907 C	RF and Microwave Circuit Design	100	04	0	0	04
Elective	EC 903 E	**Elective I** 1. Advanced Communication Techniques 2. Quantum Mechanics 3. Statistical Information Processing 4. Cognitive Radio 5. Laser & Optoelectronics 6. Principles of Signal and Systems 7. Advanced Digital Electronic Circuits 8. MOOCs/NPTEL	100	04	0	0	04
Elective	EC 904 E	**Elective II** 1. Wireless & Mobile Communication 2. Advanced RF & Antenna Engineering 3. DSP & Architecture 4. Digital Communication Networks & Protocol 5. Digital Image Processing 6. Principles of Modern CDMA/MIMO/OFDM Wireless Communication 7. Advanced Analog Electronic Circuits 9. MOOCs/NPTEL	100	03	0	0	03
Compulsory Foundation Course	Computer Skill III	JAVA Software	100	03	0	0	04
Lab 1	EC 905P	Optical communication Lab	100	0	0	04	02
Lab 2	EC 906P	Microwave & Antenna Engineering lab	100	0	0	04	02
Total			**700**	15	0	08	**23**

Semester II

Course Type	Course Code	Course Name	Marks	L	T	P	Credits
Core 1	EC 1001 C	Optical Networks	100	04	0	0	04
Core 2	EC 1002 C	Antennas & Radiating Systems	100	04	0	0	04
Elective	EC 1003 E	**Elective I** 1. Nano scale Physics & Microelectronic Circuits 2. Satellite Communication 3. Internet of Things 4. Modern Data Transmission Technology 5. Software defined networking 6. Modern Digital Communication Techniques 7. Introduction to Coding Theory 8. Mathematical Methods and Techniques in Signal Processing 9. Electrical Measurement & Instrumentation 10. MOOCs/NPTEL	100	04	0	0	04
Elective	EC 1004 E	**Elective II** 1. EMI/EMC 2. MIMO Communication Systems 3. Network Security and Cryptography 4. Real Time Embedded System 5. VLSI design 6. Broadband Network and Network Management 7. Principles of Digital Communications 8. Introduction to Photonics 9. Advanced Control Theory 10. MOOCs/NPTEL	100	03	0	0	03
Sessional 1	EC 1005 P	Term Paper Leading to Thesis	100	0	0	04	02
Sessional 2	EC 1006 P	Project Design	100	0	0	04	02
			600	12		8	**19**

Semester III

Course Type	Course Code	Course Name	Marks	L	T	P	Credits
Dissertation	EC 1106 C	Dissertation Phase-I	200	0	0	12	6
Dissertation	EC 1107 C	Thesis Seminar Interim & Viva-Voce	200	0	0	8	4
	EC 1108 C	Research Methodology	100	4	0	8	4
Audit Course		**Audit Course I:** 1. Fundamental of Business managements 2. Lasers and Optoelectronics 3. Photonics and Optical Switching 4. Fundamentals of Image Processing		5			00
Total			500	02	0	28	**17**

Semester IV

Course Type	Course Code	Course Name	Marks	L	T	P	Credits
Dissertation	EC -1206C	Dissertation Phase - II	200	0	0	12	6
Dissertation	EC 1207 C	Thesis Seminar Final & Viva-Voce	200	0	0	12	6
Audit Course		**Audit Course II:** 1. Information Theory and Coding 2. Bioinformatics 3. Remote Sensing 4. Artificial Intelligence 5. Biomedical Engineering 6. Advanced Optoelectronics 7. Satellite Communication 8. Advanced Microwave Engineering		4	0	0	00
Elective Foundation	EC 1205 EF	**Elective V** 1. Communicative English 2. Yoga **3.** NSS and Social Services	50	0	0	0	02
Total			400	04		24	**14**

*70 (Theory) + 30 (Internal Assessment). Total max. credit: 72 (Range: 68-72).
Elective offered to other Departments in even semesters: Sensor and System, Credit: 3 & Marks: 100

1st Semester:

EC -901 C	Advanced optical Fiber Communication System

Optical fiber and its characteristics: Optical fiber, Types of optical fiber, Fabrication techniques of optical fiber, Different types of losses in optical fiber, Group velocity Dispersion, Polarization mode dispersion.
Nonlinearities in optical fiber: Self Phase Modulation, Cross Phase Modulation, Four Wave Mixing.
Optical source and detector: LED, LASER, Laser diode, DFB laser, PIN photo detector, APD.
Optical Amplifier: Erbium doped fiber amplifier, semiconductor optical amplifier, Raman amplifier.
Multiplexing technique: WDM, OFDM, Optical CDMA.
Optical system performance and monitoring system: eye diagram, eye opening penalty, Q, BER, OSNR, OTDR.
Link analysis: Single channel point to point, WDM point to point.
Active and passive optical components and subsystems: Coupler, MUX/DEMUX, OADM, ROADM, Filter, FBG, CFBG, MZI, EAM, AWG. wavelength converter, All-optical regenerator, Optical switches.
Pulse propagation in optical fiber: Nonlinear Schrodinger equation, split step Fourier method.
Dispersion and nonlinearity management system: Dispersion map, Optical equalization Advanced Modulation formats, Optical phase conjugation, Coherent optical communication.

Text Books:

1. Fiber-Optic Communication Systems, by Govind P. Agrawal, 4th Edition
2. Optical Networks-A Practical Perspective, by Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki, 3rd Edition
3. Optical fiber communications by Gerd Keiser-McGraw Hill, 5th Edition
4. Optical fiber communications: Principles and practice by John M. Senior-Prentice Hall of India, 3rd Edition

EC 907 C	RF and Microwave Circuit Design

Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.

Microwave Network Analysis: Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.

Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.

Nonlinearity And Time Variance Inter-symbol interference: random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Microwave Semiconductor Devices And Modelling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, Mixers design.

References:

1. Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", AuthorHouse, 2009.
2. D. M. Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.
3. R. Ludwig and P. Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.
4. S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.

EC 903 E	Advanced Communication Techniques

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

Real Time Communications over Internet: Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP. Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

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

IP address lookup-challenges: Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Admission control in Internet: Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.

IPV4, IPV6, IP tunnelling: IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

References:

1. Zhang Wang, "Internet QoS", Morgan Kaufman, 2001.
2. George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005.

EC – 903E	Quantum Mechanics

The Limits of Classical Physics: Black body radiation, the laws of Wien and Rayleigh-Jeans, Planck's hypothesis and Planck's energy distribution law in black body radiation. The photoelectric effect. The Compton effect. Electron diffraction and de Broglie hypothesis. The Bohr atom, Bohr's postulates, experimental consequences, the Correspondence Principle.

Wave Packets and the Uncertainty Relations: The Gaussian wave packet, the propagation of wave packet, group velocity, energy quantization of radiation and the de Broglie relation to develop the concept of wave packet

associated with a free particle. The uncertainty relations, measurement of position of an electron, the two-slit experiment, the reality of orbits in Bohr atom, the energy-time uncertainty relation.

The Schrodinger Wave Equation: Matter wave, wave function and its physical significance, The free particle Schrodinger equation. The probability interpretation. Flux conservation, probability current density, equation of continuity. Physical observables as quantum mechanical operators. The position, momentum and energy operators. Expectation value of operators and the reality of expectation values. The Schrodinger equation for a particle in a potential.

Eigenfunctions and eigenvalues: Separation of time and space dependent parts of the Schrodinger equation. The energy eigenvalue equation. The particle in a box, eigenfunctions and eigenvalues, stationary states, orthogonality of eigenfunctions, normalization of eigenfunctions, fundamental postulates of quantum mechanics, expansion of wave function and the interpretation of the expansion coefficients. Parity. Momentum eigenfunctions, non normalizable states, degeneracy and simultaneous eigenfunctions.

One Dimensional Potentials: The potential step, reflection and transmission coefficients. The potential well and bound states. The potential barrier and tunnelling. One dimensional harmonic oscillator

Three Dimensional Potential: The hydrogen atom, the separation of radial and angular variables. The angular equation, algebraic method for solving the angular momentum eigenvalue problem, raising and lowering operators, Legendre function. The radial equation, simplification of the radial equation, eigenfunctions and eigenvalues, quantum numbers, degeneracy of the states. Wave functions and relation to "orbits".

Books:

1. Quantum Physics: Stephen Gasiorowicz, John Wiley & Sons.
2. Quantum Mechanics: Leonard I. Schiff, Tata McGraw Hill.
3. Introduction to Quantum Mechanics: D. J. Griffith, Pearson Education.

EC -903 E	Statistical Information Processing

Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables. Random process: Expectations, Moments, Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and auto covariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications ,Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm.

Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean-Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple Parameter Estimation Best Linear Unbiased Estimator ,Least-Square Estimation Recursive Least-Square Estimator.

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

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

Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements ,Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

References:

1. Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.
2. R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.
3. Mourad Barkat , "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.

EC -903 E	Cognitive Radio

Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Research Challenges in Cognitive Radio: Network layer and transport layer issues, crosslayer design for cognitive radio networks.

References:

1. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
2. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

EC -904 E	Laser and Optoelectronics

Quantum Theory of Atomic Energy Levels – Radiative and Nonradiative decay of excited state atoms – Emission Broadening and linewidth – Radiation and Thermal equilibrium – Conditions for laser action – Laser Oscillation above threshold - Laser Amplifiers – Requirements for obtaining population inversion – Rate Equations for three and four level systems – Laser pumping requirements – Laser Cavity modes – Stable resonators – Gaussian beams-

Special Laser Cavities – Q-switching and Mode locking – Generation of ultra fast Optical pulses- Pulse compression

Atomic Gas Lasers – He-Ne, Argon ion, He-Cd — Molecular Gas Lasers – CO2, Excimer, Nitrogen—X-Ray Plasma Laser — Free-Electron Laser — Organic Dye lasers — Solid-state lasers – Ruby, Nd:YAG, Alexandrite, Ti:Sapphire

Electronic and Optical properties of semiconductors- electron-hole pair formation, PN Junction, diffusion, injection efficiency, quantum efficiency, homo-junction and hetero-junction, Excitation absorption, donor-acceptor and impurity band absorption, LED, Semiconductor lasers, Hetero-junction Lasers, quantum well lasers, VCSEL, DFB and DBR Lasers

Detection of Optical radiations – Basic Principle, Thermal detectors, Photomultipliers, photoconductive detectors, Photodiodes, Avalanche photodiodes, CCDs, Image Intensifiers, Arrays, Solar Cells, noise considerations

Optoelectronic Modulators – Basic principle, Birefringence, Optical Activity, EO, AO and MO Effects and modulators

References:

1. Laser Fundamentals – W.T. Silfvast, Second Edition, Cambridge University Press, 2004
2. Principles of Lasers – O. Svelto, Fourth edition, Springer, 1998
3. Photonics: Optical Electronics in Modern Communications – A. Yariv and P. Yeh, Sixth Edition, Oxford University Press, 2007
4. Semiconductor Optoelectronic devices – Pallab Bhattacharya, Prentice Hall of India, 1995 5. Semiconductor Optoelectronics – Jasprit Singh, Tata Mc Graw Hill, 1995
6. Optoelectronics - an Introduction – Wilson and Hawkes, Prentice Hall, 1998

EC -904 E	Wireless & Mobile Communication

Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE,

Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations)

Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

References:

1. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
2. T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002.

EC -904 E	Advanced RF & Antenna Engineering

The Static Electric Field: Introduction, Electric charge as point charge, Charge distribution, Principle of superposition of fields, Electric field intensity at a point due to a dipole, Divergence of flux density, Energy.

Potential and Capacitance: The electric scalar potential, Potential difference and Potential, The potential field of a point charge, The electric field as the gradient of the electric potential, Poisson's and Laplace's equation, Maxwell's curl equation for static electric field. The Static Electric Field in Dielectrics: Dielectrics, polarization, Effect of polarization induced in a dielectric, Boundary relations in two perfect dielectric media, Method of images, Point charge near an infinite grounded conducting plane.

The Steady Electric Current: Divergence of J and continuity relation for current, Current and field at the conductor insulator boundary, Boundary conditions – conductor to conductor boundary, Duality of J and D.

The Steady Magnetic Field: Magnetic flux density or Magnetic induction and Magnetic flux, Curl of H, Magnetic scalar potential, Magnetic vector potential, Nature of Magnetic materials, Magnetic field and Magnetization, Boundary relations in Magnetic fields.

Time Varying Fields and Maxwell's Equations: Displacement current, Maxwell's Equations-Modified Ampere's law, Maxwell's Equations. Electromagnetic Waves. The production of electromagnetic waves by an antenna, The wave equation for waves in space, Polarization, Wave polarization in lossy dielectric medium, Conductors and dielectrics. Wave propagation in good dielectrics, Wave propagation in good conductors, Depth of penetration-Skin depth, The Poynting vector and Power flow, Reflection of uniform plane waves by perfect dielectric-Normal incidence, Reflection by perfect dielectric-Oblique incidence, Reflection by perfect conductor-Normal incidence, Surface impedance of a conductor.

Printed Antennas: Basics of Antenna fundamentals Microstrip Antennas: Radiation mechanism; Basic characteristics; Feeding techniques; Broadbanding techniques; Printed antennas for mobile and portable wireless equipment. Reconfigurable antennas, wearable antenna, antennas for RFID systems.

Dielectric Resonator Antennas (DRA): Dielectric Resonators, modes, radiation mechanisms, feeding mechanisms, characteristics, design and applications; materials for DRA, integration with active devices.

Ultra wideband (UWB) Antennas: Monopole antennas, UWB Slot antennas, Loop antennas, Tapered slot antennas, Impulse Radiating antennas, Conical antennas, Frequency independent antennas, basic principles and characteristics, Radiation mechanisms. Antennas for 4G/5G applications, antennas for on-board systems, antennas for medical applications, antennas for radiometry and remote sensing.

Antenna Measurements: Basic principles, antenna radiation measurements using anechoic chamber and compact range techniques, measurements of antenna patterns, gain, and efficiency, measurement circularly polarized antennas.

References:

1. Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons,4th edition,2016
2. R.C.Johnson and H.Jasik, "Antenna Engineering hand book", Mc-Graw Hill, 1984.
3. John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for All Applications", Tata Mcgraw-hill 2002

EC -904 E	DSP & Architecture

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 – Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.

Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).

FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.

High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

References:

1. Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011
2. Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.

EC -904 E	Digital Communication Networks and Protocol

Short introduction- Discrete time systems & signals, z-transform, difference equation, filter design by transformation-impulse and step invariant, bi-linear z-transform, matched z transform, signal model-AR, MA, ARMA, state variable model, lattice structure.

FIR filter design: frequency windowing technique, equi ripple chebyshev & butterworth criterion. Filter performance and design in presence of noise, FIR filters banks-subband decomposition. Inverse filtering deconvolution and equalization techniques- Weiner, linear prediction etc.,

Signal reconstruction: time frequency analysis STFT, WT,DSP hardware-design methodologies, popular architectures and overview of programming application notes. filter implementation: topology, scaling, co-efficient quantization, signal quantization, sensitivity analysis. Overview of communication & networking

References:

1. J.G. Proakis, Manolakis "Digital Signal Processing", Pearson, 4th Edition
2. A. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall

Computer Skill III	**JAVA Software**

Programming with Java:

1. Fundamentals of Object-Oriented Programming, Java Evolution, Java History 2. Java Features: Overview of Java Language, Constants, Variables and Data Types, Operators and Expressions, Decision making, branching and looping. 3. Classes, Objects and Methods, Arrays, String and Collections, Interfaces, Packages, Managing Errors and Exceptions 4. Multithreading, Applet Programming, Java AWT, Event Handling 5. Java I/O Handling, Java Database Connectivity, B. Numerical methods (Selective)

Text Book:

1. Programming in Java by Sachin Malhotra and Saurabh Choudhary, Oxford Higher education.

2nd Semester:

EC- 1001 C	**Optical Networks**

Introduction: Different kinds of attenuation in optical fiber, Optical bandwidth, Light Transmission in Optical Fibers, Signal Impairments Along the Lightpath; Optical Transmitters and Modulators, Optical Receivers; Optical system Components – Couplers, Isolators & Circulators, Multiplexers & Filters.

Optical Networking: Introduction and Challenges: Advantages of optical network, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network

Optical Networking Components: OLT, OADM, OXC, CLOS architecture, MEMS, wavelength convertors, Optical Line Amplifiers

SONET/SDH: SONET/SDH layers, Optical transport network, IP, routing and forwarding, MPLS.

Network Survivability: Basic concept, Protection in SONET/SDH, Protection in IP Network, Optical Layer Protection scheme.

Optical switching: Optical packet switching, header and packet format, optical burst switching.

WDM Network Design: The optical layer, Node Designs, Optical layer cost tradeoff, Lightpath topology design, Routing and wavelength assignment.

Optical Access Network: Optical time division multiplexing, Synchronization, buffering, Introduction to PON, GPON, AON.

Text Books:

1. Optical Networks-A Practical Perspective, by Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki, 3rd Edition

2. WDM optical networks: concepts, design and algorithms- C.Sivaram murthy and Mohan Gurusamy- Prentice Hall of India, 2002
3. Optical Networks, by Black,Miller L Scott,Muhammad Ali Mazidi

EC- 1002 C	Antennas & Radiating Systems

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

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

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

Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture.

Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Text Books:

1. Electromagnetic Waves & Radiating Systems, Jordon & Balmin
2. Antenna Theory: Analysis & Design, by Balanis
3. I.J.Bhal and P.Bhartia, "Micro-strip antennas", Artech house, 1980.

EC- 1003 E	Nanoscale Physics & Microelectronic Circuits

Introduction

Nanostructures: the impact
Mesoscopic observables in nanostructures
Space and time scales
Nanostructures and nanodevices

A brief survey of the bulk electronic structure of solids

Solids: amorphous and crystalline materials

Crystal Structure: lattice translation vectors, lattice with a basis, unit cell, direct and reciprocal lattices, types of lattices, Brillouin zones.

Free electron model of solids: Free electron theory of metals, density of states, Fermi energy, Fermi temperature, Fermi wave vector, electronic specific heat, Drude model of conductivity, Hall effect.

Band Theory of Solids: Nearly free electron model, electrons in a periodic potential, Bloch functions, energy bands and band gaps, number of states in a band, effective mass of an electron in a band, classification into metals, semiconductors and insulators, tight-binding approximation, concept of holes and mobility of electrons and holes.

Quantum confined systems
Nanostructure materials
Quantization in heterojunction systems
Lateral confinement: quantum wires and quantum dots

Electron transport in nanostructures
Tunneling in planar barrier structures
Landauer formula
Transport in quantum waveguide structures

Books

1. Introduction to Solid State Physics: Charles Kittel, Wiley Eastern Ltd.
2. Basic Solid State Physics: Arun Kumar Raychaudhuri,Levant Books
3. Solid State Physics: H. Ibach and H. Luth, Springer
4. Transport in nanostructures: D. K. Ferry, S. M. Goodnick & J. Bird, Cambridge
5. Theory of Quantum Transport: Dmitry A. Ryndyk, Springer
6. Nanostructures Theory and Modeling: C. Delerue & M. Lannoo, Springer.

EC- 1003 E	Satellite Communication

Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.
Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

Modulation and Multiple Access Schemes used in satellite communication: Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ISRO. GPS.

Text Books:

1. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.
2. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.
3. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.

EC- 1003 E	Internet of Things

Smart cities and IoT revolution: Fractal cities, From IT to IoT, M2M and peer networking concepts, Ipv4 and IPV6.
Software Defined Networks SDN: From Cloud to Fog and MIST networking for IoT communications, Principles of Edge/P2P networking, Protocols to support IoT communications, modular design and abstraction, security and privacy in fog.

Wireless sensor networks: introduction: IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and configuration.

Smart objects as building blocks for IoT: Open source hardware and Embedded systems platforms for IoT, Edge/gateway, IO drivers, C Programming, multithreading concepts.

Operating systems requirement of IoT environment: study of mbed, RIoT, andContiki operating systems, Introductory concepts of big data for IoT applications.

Applications of IoT: Connected cars IoT Transportation, Smart Grid and Healthcare sectors using IoT, Security and legal considerations, IT Act 2000 and scope for IoT legislation.

Text Books:

1. A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", VPT publisher, 2014.
2. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
3. Samuel Greenguard, "Internet of things", MIT Press, 2015.

EC- 1003 E	Modern Data Transmission Technology

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

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

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

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

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

Congestion avoidance: RED TCP Throughput Analysis, Quality of Service in Packet
Networks. Network Calculus, Packet Scheduling Algorithms.

Text Books:

1. D. Bertsekas and R. Gallager, “Data Networks”, 2nd Edition, Prentice Hall, 1992.
2. Walrand, “Communications Network: A First Course”, 2nd Edition, McGraw Hill, 2002.

EC- 1003 E	Software Defined Networking

Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.
Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of OpenFlow protocol.
Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.
Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hadrware-based; Programmable Network Hardware.
Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.
Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering

Text Books:

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

EC -1004 E	EMI/EMC

Natural and Nuclear sources of EMI / EMC : Introduction, Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI.

EMI from apparatus, circuits and open area test sites : Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive intermodulation, crosstalk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.

Radiated and conducted interference measurements: Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements. UNIT-IV:ESD, Grounding, shielding, bonding and EMI filters : Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design. ESD, Electrical fast transients / bursts, electrical surges.

Cables, connectors, components: Introduction, EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, opto-isolators, Transient and Surge Suppression Devices.

EMC standards- National / International .: Introduction, Standards for EMI and EMC, MIL Standards, IEEE/ANSI standards, CISPR/IEC standards, FCC regulations, Euro norms, British Standards, EMI/EMC standards in JAPAN, Conclusions.

Text Books :

1. Engineering Electromagnetic Compatibility by Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi,2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 – 9.

References:

1. Introduction to Electromagnetic Compatibility, NY, John Wiley, 1992, by C.R. Pal.

EC- 1004 E	MIMO Communication Systems

Introduction to Multi-antenna Systems: Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Diversity: Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation

The generic MIMO problem: Singular Value Decomposition, Eigenvalues and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion in MIMO systems, Disadvantages of pre distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining, Channel state information.

Codebooks for MIMO: Beamforming, Beamforming principles, Increased spectrum efficiency, Interference cancellation, Switched beamformer, Adaptive beamformer, Narrowband beamformer, Wideband beamformer

Case study: MIMO in LTE, Codewords to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

Channel Estimation: Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

References:

1. I.J.Bhal and P.Bhartia, “Micro-strip antennas”, Artech house, 1980.
2. R.C.Johnson and H.Jasik, “Antenna Engineering hand book”, Mc-Graw Hill, 1984.
3. John D Kraus, Ronald J Marhefka, Ahmad S Khan, “Antennas for All Applications”,Tata Mcgraw-hill.

EC- 1004 E	Network Security and Cryptography

Network Security: Introduction, Basic Security Concepts, Threats, Vulnerabilities, and Attacks, Encryption, Digital Signatures, and Certification Authorities, Kerberos Key Exchange, Encryption on the World Wide Web, E-Mail Security, Operating System Security, LAN Security, Media and Protocols, Routers and SNMP, Virtual Private Networks, Firewalls, Biometrics, Policies and Procedures, Auditing, Monitoring, and Intrusion Detection, Crisis Management, Cookies and Cache, Security of Web-based Systems.

References:

1. William Stallings, "Cryptography and Network Security, Principles and Practices", Pearson Education, 3rd Edition.
2. Christopher M. King, ErtemOsmanoglu, Curtis Dalton, "Security Architecture, Design Deployment and Operations", RSA Press.

EC- 1004 E	Real Time Embedded System

MOOC's / NPTEL

EC- 1004 E	VLSI design

MOS TRANSISTOR THEORY: NMOS and PMOS transistors, CMOS logic, MOS transistor theory – Introduction, Enhancement mode transistor action, Ideal I-V characteristics, DC transfer characteristics, Threshold voltage Body effect- Design equations- Second order effects. MOS models and small signal AC characteristics, Simple MOS capacitance Models, Detailed MOS gate capacitance model, Detailed MOS Diffusion capacitance model.

CMOS TECHNOLOGY AND DESIGN RULE : CMOS fabrication and Layout, CMOS technologies, P -Well process, N -Well process, twin -tub process, MOS layers stick diagrams and Layout diagram, Layout design rules, Latch up in CMOS circuits, CMOS process enhancements, Technology – related CAD issues, Fabrication and packaging.

INVERTERS AND LOGIC GATES : NMOS and CMOS Inverters, Inverter ratio, DC and transient characteristics , switching times, Super buffers, Driving large capacitance loads, CMOS logic structures , Transmission gates, Static CMOS design, dynamic CMOS design.

CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION : Resistance estimation, Capacitance estimation, Inductance, switching characteristics, transistor sizing, power dissipation and design margining. Charge sharing .Scaling.

VLSI SYSTEM COMPONENTS CIRCUITS AND SYSTEM LEVEL PHYSICAL DESIGN : Multiplexers, Decoders, comparators, priority encoders, Shift registers. Arithmetic circuits – Ripple carry adders, Carry look ahead adders, High-speed adders, Multipliers. Physical design – Delay modelling ,crosstalk, floor planning, power distribution. Clock distribution. Basics of CMOS testing.

REFERENCES:
1. Neil H.E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Pearson Education ASIA, 2nd edition, 2000.
2. John P.Uyemura "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc., 2002.
3. Eugene D.Fabricius, Introduction to VLSI Design McGraw Hill International Editions, 1990.
4. Pucknell, "Basic VLSI Design", Prentice Hall of India Publication, 1995. 5. Wayne Wolf "Modern VLSI Design System on chip. Pearson Education, 2002.

EC -1004 E	Broadband Network and Network Management

Synchronous and Asynchronous Networks, Optical Fiber based Backbone and Information Superhighways, SONET & SDH standards. IP over SONET and WDM, STS & STM Framing, ATM and STM systems, ATM Layers. User Network & Network-Network Interfaces. Virtual paths and Virtual circuits, Cell Loss Effects, Intelligent Networks. Network Management and Control, TMN Architecture and Functional Requirements. Interface and Protocol Requirements, Information Modeling and Model representations. System Management Functions, OSI System Management, Internet SNMP, ODP/OMG. COBRA as technologies for TMN.

References:

1. Network Management: Principles and Practice 2nd Edition, Kindle Edition

MOOCs/NPTEL

Audit Course	Fundamental of Business Managements

Introduction to Entrepreneurship, Introduction and Reflection on Entrepreneurship, Business Plan Overview and Introduction, Business Plan Assignment, HP Life Assignments. Unique value proposition. Marketing Plan Part 2: Competition, Strategy and Pricing, HP Life Assignments. Strategic Planning. Setting Prices. Marketing Plan Part 3. Marketing Strategy and Sales Forecast, Managing contact information, Customer relationship management, Maximizing Capacity. Managing Contact Information, Customer Relationship Management. Hiring Staff. Inventory Management. IT for Business Success. Financial, Executive Summary, First Complete Draft & Peer Review, Basics of Finance. Profit and Loss. Finding Funding. Cash Flow. Completed Rough Draft and Self-Scoring.

References:

1. Media, T. S. of E. (2015). *Start Your Own Business, Sixth Edition: The Only Startup Book You'll Ever Need* (Sixth Edition). Irvine, California: Entrepreneur Press. 766 pages. ISBN: 978-1-59918-556-9.

Audit Course	Lasers and Optoelectronics

This course is an introduction to the principles, design, and applications of optoelectronic devices. The course begins with a description of the interaction of light with semiconductor materials in a p-n junction configuration. This includes the phenomena of absorption, electroluminescence, and stimulated emission. The distinction between direct and indirect compound semiconductors materials is noted. Basic devices are then described: photodiodes, light emitting diodes (LEDs), semiconductor optical amplifiers, and laser diodes are then described. Array detectors,

including complementary metal-oxide semiconductor (CMOS) and charge-coupled devices (CCD) arrays, and array LEDs are then introduced. Basic specifications and applications of each of these devices are described, including solar cells, imaging with array detectors, and LED displays.

References:

1. Optoelectnics and Photonics principles and practices, Second Edition S.O.Kasap Solid State Electronic Devices (6th Edition), Ben Streetman , Sanjay Banerjee

Audit Course	**Photonics and Optical Switching**

Electro-absorption modulators, quantum well EAM, electro-optic modulators, quantum well EOM, self electro-optic effect device, bipolar controller modulator, optoelectronic amplification. Programmable memory device. Switching speed and energy. Opto-electronic integrated circuits: Hybrid and Monolithic integration, Integrated optical Transmitters and Receivers. Guided wave devices: Waveguides, couplers, splitters and combiners. Active guided wave Devices, Optical Bi-stability, Digital Optics. Optical switches, temporal, spatial, wavelength and spectral domain switching, multidimensional and multilevel photonic switching. Self routing. ATM switching.

References:

1. Integrated Photonics: Fundamentals, By GinésLifante, John Wiley and Sons.
2. Integrated Optics, by Robert G. Hunsperger, Springer

Audit Course	**Fundamentals of Image Processing**

UNIT-I:DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS

Elements of digital image processing systems, Vidicon and Digital Camera working principles, Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries, 2D transforms -DFT, DCT, KLT, SVD.

UNIT II: IMAGE ENHANCEMENT

Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement.

UNIT III: IMAGE RESTORATION

Image Restoration - degradation model, Unconstrained restoration - Lagrange multiplier and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations-spatial transformation.

UNIT IV: IMAGE COMPRESSION

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG.

UNIT V: IMAGE SEGMENTATION

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

References:

1. William K. Pratt, , Digital Image Processing' , John Wiley, New York, 2002.
2. Kenneth R. Castleman, "Digital Image Processing", Pearson, 2006.

Audit Course	Information Theory and Coding

ERROR CONTROL CODING: BLOCK CODES

Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder - CRC

ERROR CONTROL CODING: CONVOLUTIONAL CODES

Convolutional codes – code tree, trellis, state diagram - Encoding – Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding

SOURCE CODING: TEXT, AUDIO AND SPEECH

Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

SOURCE CODING: IMAGE AND VIDEO

Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I,B,P frames, Motion estimation, Motion compensation, H.261, MPEG standard

References:

1. K Sayood, "Introduction to Data Compression" 3/e, Elsevier 2006
2. Amitabha Bhattacharya, "Digital Communication", TMH 2006

Audit Course	Bioinformatics

UNIT I - HISTORY, SCOPE AND IMPORTANCE Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities - internet basics- HTML - introduction to NCBI data model- Various file formats for biological sequences

UNIT II - DATABASES - TOOLS AND THEIR USES Importance of databases - Biological databases-primary sequence databases- Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases - structure databases - bibliographic databases - specialized genomic resources- analysis packages

UNIT III - SEQUENCE ALIGNMENT METHODS Sequence analysis of biological data-Significance of sequence alignment- pairwise sequence alignment methods- Use of scoring matrices and gap penalties in sequence alignments- multiple sequence alignment methods - Tools and application of multiple sequence alignment.

UNIT IV - PREDICTIVE METHODS USING DNA AND PROTEIN SEQUENCES Gene predictions strategies - protein prediction strategies - molecular visualization tools-phylogenetic analysis: Concept of trees- phylogenetic trees and multiple alignments.

UNIT V - DRUG DISCOVERY PROCESS Discovering a drug - target identification and validation - identifying the lead compound - optimization of lead compound - chemical libraries.

References:

1. S.C. Rastogi & others, "Bioinformatics- Concepts, Skills, and Applications", CBS Publishing, 2003.
2. S. Ignacimuthu, S.J., "Basic Bioinformatics', Narosa Publishing House, 1995.

Audit Course	Remote Sensing

Unit 1: Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.

Unit 2: Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned space crafts–sun synchronous and geo synchronous satellites –Types and characteristics of different platforms –LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD etc.

Unit 3: Photographic products: B/W, colour, colour IR film and their characteristics –resolving power of lens and film – Opto-mechanical electro optical sensors –across track and along track scanners multispectral scanners and thermal scanners–geometric characteristics of scanner imagery - calibration of thermal scanners.

Unit 4: Scattering System: Microwave scatterometry, types of RADAR –SLAR –resolution –rangeand azimuth – real aperture and synthetic aperture RADAR. Characteristics of Microwave image stopographic effect-different types of Remote Sensing platforms –airborne and space borne sensors -ERS, JERS, RADARSAT, RISAT - Scatterometer, Altimeter-LiDAR remote sensing, principles, applications.

Unit 5: Thermal And Hyper Spectral Remote Sensing: Sensors characteristics-principle of spectroscopyimaging spectroscopy–fieldconditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing –thermal sensors, principles, thermal data processing, applications.

Unit 6: Data Analysis: Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics-visual and digital interpretation–Basic principles of data processing –Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping.

References:

1. Lillesand. T.M. and Kiefer. R.W, "Remote Sensing and Image interpretation", 6thEdition, John Wiley & Sons, 2000.
2. John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", 2nd Edition, Prentice Hall,1995.
3. Richards, John A., Jia, Xiuping, "Remote Sensing Digital Image Analysis",5th Edition, Springer-Verlag Berlin Heidelberg, 2013.
4. Paul Curran P.J. Principles of Remote Sensing, 1st Edition, Longman Publishing Group, 1984.
5. Charles Elachi, Jakob J. van Zyl, "Introduction to The Physicsand Techniques of Remote Sensing", 2nd Edition, Wiley Serie, 2006.
6. Sabins, F.F.Jr, "Remote Sensing Principles and Image Interpretation", 3rd Edition, W.H.Freeman& Co, 1978

Audit Course	Artificial Intelligence

Unit 1: **What is AI (Artificial Intelligence)? :** The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final WordProblems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production Characteristics, Production System Characteristics, And Issues In The Design Of Search Programs, Additional Problems. Generate And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means Ends Analysis.

Unit 2: Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge Representation. Using Predicate Logic: Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

Unit 3: Symbolic Reasoning Under Uncertainty: Introduction To No monotonic Reasoning, Logics For Non-monotonic Reasoning. Statistical Reasoning: Probability And Bays' Theorem, Certainty Factors And Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory

Unit 4: Fuzzy Logic. Weak Slot-and-Filler Structures: Semantic Nets, Frames. Strong Slot-and-Filler Structures: Conceptual Dependency, Scripts, CYC

Unit 5: Game Playing: Overview, And Example Domain: Overview, Mini-Max, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components Of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques. Understanding: What is understanding? What makes it hard? As constraint satisfaction

Unit 6: Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse And Pragmatic Processing, Spell Checking Connectionist Models: Introduction: Hopfield Network, Learning In Neural Network, Application Of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI And Symbolic AI.

References:

- Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
- Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.

Audit Course	Bio medical Engineering

UNIT I: SCIENCE OF MEASUREMENT

Measurement System – Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary standards.

UNIT II: DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple – characteristics.

UNIT III: PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectro-photometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer.

UNIT IV: SIGNAL CONDITIONING & SIGNAL ANALYSER AC and DC Bridges –wheat stone bridge, Kelvin, Maxwell, Hay, Schering – Concepts of filters, Pre-amplifier – impedance matching circuits – isolation amplifier. Spectrum analyzer.

UNIT V: DISPLAY AND RECORDING DEVICES Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Demonstration of the display and recording devices.

References:

1. R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002
2. Steven M. Kay, "Modern spectral estimation theory and application ", Prentice Hall, Englewood Cliffs, NJ, 1988
3. D C Reddy "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005

MOOC's / NPTEL

Audit Course	**Advanced Optoelectronics**

Lightwave fundamentals: Refraction and reflection; Wave equations, plane waves, and spherical waves; Dispersion and group velocity; Doppler effect; Total internal reflection; Polarization, polarizers, and wave-plates; Interference; and Diffraction, and Fresnel zone plates.

Waveguide and Fibers: Planar waveguides, Slab waveguides, Modal and waveguide dispersion, Numerical aperture, Step-index fibers, Graded-index (GRIN) fibers, Bit rate, Electrical and optical bandwidth, Attenuation, fiber manufacturing.

Optical detection: Optoelectronic effect; PN junction; Semiconductor detectors, including PN, PIN and Avalanch diodes; Photomultipliers; CCD imagers; Quantum efficiency; Noises; and SNR.

Lasers: Optical resonators; Fabry-Perot Etalon; Laser modes; Spectral bandwidth and coherence length; and Solid-state lasers, diode lasers, and gas lasers.

Optical displays: Liquid crystals; Plasmas; LEDs; Flat panel displays; Introduction to MEMS; MEMS scanning mirrors; Digital micromirror devices (DMDs) and portable projectors; and MEMS-based Pico-projectors.

Fiber optics and optical communication systems: Waveguides and modes; Single- and multi-mode fibers; Wavelength-division multiplexing (WDM); Fiber communication systems; Fiber-to-the-home (FTTH); FTTx; Optical MEMS switches; and All-optical switching and all-optical network.

References:

4. Optoelectnics and Photonics principles and practices, Second Edition S.O.Kasap Solid State Electronic Devices (6th Edition), Ben Streetman , Sanjay Banerjee

Audit Course	Satellite Communication

UNIT – I: SATELLITE ORBITS

Introduction Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage- Launching Procedures -launch vehicles and propulsion.

UNIT – II : **SPACE SEGMENT AND SATELLITE LINK DESIGN**

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite uplink and downlink Analysis and Design, link budget, E/N calculation- performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency considerations- System reliability and design lifetime.

UNIT – III: SATELLITE ACCESS

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system,Digital video Brocast, multiple access: FDMA, TDMA, CDMA, Assignment Methods,Spread Spectrum communication, compression – encryption

UNIT – IV : EARTH SEGMENT

Earth Station Technology-- Terrestrial Interface, Transmitter and Receiver, Antenna Systems TVRO, MATV, CATV, Test Equipment Measurements on G/T, C/No, EIRP, Antenna Gain.

UNIT – V:SATELLITE APPLICATIONS

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB)- World space services, Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet

References:

1. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.
2. N.Agarwal, 'Design of Geosynchronous Space Craft, Prentice Hall, 1986.

Audit Course	Advanced Microwave Engineering

Introduction to microwaves and applications: advantages of microwaves, EM spectrum domain, electric and magnetic fields static electric and magnetic fields, time varying electric and magnetic fields, electromagnetic field equations, maxwell's equations for time-varying fields, meaning of maxwell's equations, characteristics of free space, power flow by microwaves, expression for propagation constant of a microwave in conductive medium, microwave applications, relation between dB, dBm, dBw.

Microwave Tubes:

Limitation of conventional tubes, microwave tubes, velocity modulation, method of producing the velocity modulation, principle of operation of two cavity klystron, reflex klystron principle of operation, velocity modulation in reflex klystron, applegate diagram with gap voltage for a reflex klystron. Principle of operation of magnetron, hull cutoff condition, advantages of slow wave devices, principle of operation of TWT.

Microwave Semiconductor Devices

Microwave bipolar transistor, FET, Principle of Operation and application of tunnel diode, Principle of operation of gunn diode, application of gunn diode advantages of gunn diode, principle of operation of PIN diode, applications of PIN diode.

Scattering Matrix Parameters of microwave networks

Definition of scattering matrix, characteristics of S-matrix, scattering matrix of a two-port network, salient features of S-matrix, salient features of multiport network, losses in microwave circuits, return loss, insertion loss, transmission loss, reflection loss, impedance matrix, short circuit admittance parameters of a π-network, S-matrix of series element in the transmission line, S-matrix for E-plane Tee junction, S-matrix for H-plane Tee junctions, S-matrix for directional coupler.

Microwave Passive components

Rrectangular waveguides resonator isolator, types of attenuators, fixed attenuators, step attenuators, variable attenuators, salient features of directional coupler, parameters of directional coupler, coupling factor, directivity, applications of directional coupler.

Microwave Integrated Circuits

Salient features of MICs, types of electronic circuits, monolithic microwave integrated circuits (MMICs), film integrated circuit, advantages of MMICs, Basic materials used in MMIC fabrication, examples, characteristics and properties of substrate, conductor, dielectric and resistive materials, MMIC fabrication techniques, diffusion and ion implantation, oxidation and film deposition, epitaxial growth, lithography, etching and photo resist, deposition methods, steps involved in the fabrication of MOSFET

References:

1. "Microwave Engineering : Non-reciprocal active and passive circuits" by Joseph Helszajin, McGraw Hill, 1992.
2. "Microwave Engineering" by P.A. Rizzi, PHI, 1999.