WITH EFFECT FROM 2021-2023 ACADEMIC SESSION

SYLLABUS FOR

M. Sc. In

Electronics and Communication

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION

THE UNIVERSITY OF BURDWAN
BURDWAN

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SYLLABUS FOR M. Sc. IN
Electronics and Communication

Course Structure in Electronics and Communication

PROGRAM OUTCOME:

TO PRODUCE SKILLED MANPOWER FOR

1. RESEARCH AND DEVELOPMENT SECTORS AND INDUSTRIES RELATED TO ELECTRONICS
2. ACADEMIC INSTITUTIONS AND ORGANIZATIONS
3. ENTREPRENEURSHIP, START UP PROGRAMS AND CONSULTANCY

1 credit = 1 hour/week for theory; 2 hours/week for practical

Duration of examination for a course of 4 credits will be 2 hr. for theory papers and 4 hrs. for practical papers.

SEMESTER – I (TOTAL MARKS 300) (CREDIT 24)

Course				Marks			Credit
Course code	Type	T/P	Name	I.A.	E.T	Total	
MSEC101	Core	T	Mathematical Methods and Numerical Analysis	10	40	50	4
MSEC102	Core	T	Electromagnetic Theory and Transmission lines	10	40	50	2 2
MSEC103	Core	T	Network Analysis	10	40	50	4
MSEC104	Core	T	Physics of Semiconductor Devices	10	40	50	4
MSEC105	Core	P	Practical (Electrical and Electronics)	10	40	50	4
MSEC106	Core	P	Computational Lab (C/C++)	10	40	50	4
				Total credit			24

I.A.: Internal Assessment, E.T.: End Term

SEMESTER – II (TOTAL MARKS 300) (CREDIT 24)

Course				Marks			Credit
Course code	Type	T/P	Name	I.A.	E.T	Total	
MSEC201	Core	T	Analog and Digital Integrated Circuits	10	40	50	4
MSEC202	Core	T	Analog communication Systems	10	40	50	4
MSEC203	Core	T	Digital Signal Processing	10	40	50	4
MSEC204	Core	T	Microprocessor and microcontroller	10	40	50	4
MSEC205	Core	P	Practical	10	40	50	4
MSEC206	Core	P	Computational lab (using Python and Scilab)	10	40	50	4
				Total credit			24

SEMESTER – III (TOTAL MARKS 300) (CREDIT 24)

Course				Marks			Credit
Course code	Type	T/P	Name	I.A.	E.T	Total	
MSEC301	Core	T	Digital Communication Systems	10	40	50	4
MSEC302	Core	T	Microwave devices and circuits	5 5	20 20	25 25	2 2
MSEC303	Core	P	Advanced General Practical	10	40	50	4
MSEC304	GE	T	MSEC304: Electronic Science	5	20	25	2
MSEC305	DE	T	MSEC305-1: VLSI Technology MSEC305-2: Medical Electronics	10	40	50	4
MSEC306	DE	T	MSEC306-1: Satellite and Mobile Communications MSEC306-2: Nano Electronics MSEC306-3: May be opted from SWAYAM	10	40	50	4
MSEC307	CE	N.A.	N.A.	5	20	25	2
				Total credit			24

CE: Community Engagement Activities; DE: Discipline-centric Elective; GE: Generic elective

The Discipline-centric Elective (DE) course in Semester III may also be opted from SWAYAM

SEMESTER – IV (TOTAL MARKS 300) (CREDIT 24)

Course				Marks			Credit
Course code	Type	T/P	Name	I.A.	E.T	Total	
MSEC401	Core	T	Optical Fiber communication	10	40	50	4
MSEC402	Core	T	MSEC402-A: Power Electronics MSEC402B: Control systems	5 5	20 20	25 25	2 2
MSEC403	Float-ing/Core	P	Advanced General Practical	10	40	50	4
MSEC404	DE	T	MSEC404-1: Photonics MSEC404-2: Digital Image Processing	10	40	50	4

MSEC405	DE	T	MSEC405-1: Radar, Remote Sensing and Navigational Systems MSEC405-2: Antenna Design	10	40	50	4
MSEC406	Project/ Term paper	NA	N.A.	---	50	50	4
				Total credit			24

SEMESTER – I

Paper: MSEC101

Mathematical Methods

Course outcome:

- **To provide analytical skill to solve problems in electronics and communication**
- **To learn numerical analysis for solving problems**

1. (a) Functions of a complex variable. Brief review of the topics included in the honours syllabus: analytic functions, Cauchy-Riemann equations, integration in the Complex plane, Cauchy's theorem, Cauchy's integral formula.
(b) Proof of Taylor and Laurent expansions. Singular Points and their classification. Branch point and branch cut. Riemann sheets. Application of residue theorem to the evaluation of definite integrals and the summation of infinite series. Integrals involving branch point singularity.

2. Fourier and Laplace transforms. Inverse transforms. Convolution theorem. Solution of ordinary and partial differential equations by transform methods.

3. Introduction to Z transform Region of convergence, properties of the Z transform, Inverse transform using counter integration, complex convolution theorem, Parseval's relation. Unilateral Z transform and its application to difference equation with non zero initial condition.

4. Linear vector spaces. Subspaces. Bases and dimension. Linear independence and orthogonality of vectors. Gram-Schmidt orthogonalisation procedure. Matrix representation. The algebra of matrices. Special matrices. Rank of a matrix. Elementary transformations. Elementary matrices. Equivalent matrices. Solution of linear equations. Linear transformations. Change of Basis. Eigenvalues and eigenvectors of matrices. The Cayley-Hamilton theorem. Diagonalisation of matrices. Bilinear and Quadratic forms.

5. Probability and Statistics Basics of probability, Bayes theorem, Random variables, Probability and density functions, Binomial, Poisson and Normal distributions.

6. Numerical Analysis: Representation of real and complex numbers, statistical calculations, factorial, infinite series, iterative methods: logistic map; binary search. Imprecisions in integer and floating point arithmetic. Interpolation of datasets using the Lagrange polynomial**.** Numerical root finding: Bisection method, False position method, Newton-Raphson method. Solution of system of simultaneous linear equations: Gauss elimination, Gauss-Seidel method**,** LU decomposition algorithm. Numerical integration using Newton-Cotes quadratures: Trapezoidal and Simpson's $1/3^{rd}$ methods. Solutions of Differential Equations: Ordinary Differential Equations: Simple Euler and Runge-Kutta methods.

Recommended Books:

1. M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables.
2. George B. Arfken and Hans J. Weber (Academic Press) – Mathematical Methods for Physicists.
3. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
4. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists
5. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
6. Numerical Methods for Physics Second edition,CreateSpace Independent Publishing Platform; Second edition, Revised (June 6, 2015)
7. Computational Physics: Problem Solving with Python, 3rd Edition, Rubin H. Landau,
8. Manuel J Páez, Cristian C. Bordeianu, 2015, Wiley.

Paper: MSEC102 Electromagnetic Theory and Transmission Line

Course outcome:

- **To provide the analytical skill on Electromagnetic Theory**
- **To become able to apply the knowledge in EM design problems**

Unit – I: Transmission Lines: Transmission lines: Circuit models of transmission lines and the coaxial line; the relationship of the coaxial transmission line to Ampere's and Gauss' Laws; basic derivations of L and C; transmission and reflection coefficients, pulses and transients; the capacitively loaded line and implications for high speed-digital systems; sinusoidal waves; standing wave ratio; expressions for impedance, transmission, and reflection coefficient and power flow; Smith chart relating complex reflection coefficient and impedance; scattering parameters and the Smith chart; single and double stub tuning; quarter wave tuning; lossy transmission lines; basic concept of resonance on transmission lines; Gaussian pulse propagation: group and energy velocity

Unit – II: Introduction to Maxwell's Equations: Review of vector analysis and coordinate systems; gradient, orthogonality, and wave phase fronts; surface and volume integrals; Gauss'law; Gauss' law for magnetism; line integrals, currents and Ampere's law; divergence of a vector and Gauss' law in differential form; the divergence theorem; curl of a vector field and Ampere's law in differential form; Stoke's theorem; the Laplacian operator; Maxwell's equations;displacement current, continuity and Maxwell's equations; charges, conduction, convection, and diffusion currents; introduction to magnetic and electric potentials; Faraday's law

Unit – III: Intermediate Aspects of Maxwell's Equations: Scalar and vector potentials; generalizations of the potentials to include retardation; boundary conditions; capacitance and inductance; Poynting's theorem, power flow, and stored energy; Maxwell's equations for the sinusoidal steady-state (phasors); polarization; the steady-state Poynting vector and theorem; propagation in lossy media; forces, torque, and work

Unit – IV: Reflection and Transmission at Interfaces: EM waves at boundaries and the transmission line analog; Snell's "laws" and the critical angle; oblique incidence; Brewster's angle; TEM modes and the coaxial cable; ray model of guided waves: TE and TM waves, cut-off, and phase velocity; general formulation of wave-guide fields; hollow metallic wave guides with guiding in one dimension; planar transmission lines; general properties two dimensional-rectangular guides; power transfer; dielectric, slab-wave guides; periodic structures; optical fibres; loss and dispersion; resonators

Unit – V: Antennas, Radiation, Diffraction, and Wireless Systems: Basic antenna parameters for single and arrays of antennas; directivity and gain; effective area; Friis formula and its relation to

Recommended Books:

1. David J. Griffiths: Introduction to Electrodynamics, PHI 3rd Edition
2. Engineering Electromagnetics: Shen, Kong, Patnaik, Cengage Learning Publications,
3. India Edition
4. J. D. Jackson: Classical Electrodynamics.
5. E. C. Jordan, K. G. Balman: Electromagnetic Waves & Radiating Systems by PHI 2nd
6. Hyatt: Engineering Electromagnetics, TMH.
7. Paul, Whites, Nasar: Introduction to E.M. Fields, TMH.

Paper: MSEC103 Network Analysis and Synthesis

Course outcome:

- **To provide knowledge on network theory**
- **To apply the knowledge in electronics and communication**

1. Introduction to graph theory: Definitions- graph, tree, spanning tree, loop, co-tree, cut set, tie set, loop and nodal analysis, introduction to continuous time signal, unit step, ramp, and impulse.

2. Network Transient and steady state analysis, Transient response of simple RL,RC, series and parallel circuits, Transient response of RLC series and parallel circuits for sinusoidal and step input excitation using Laplace transform method. Differential equation formation of linear time invariant continuous systems, block diagram representation of LTI continuous networks and systems, time domain analysis of LTI network using laplace transform. Relation between impulse response and system functions, concepts of transform impedance and synthesis. 3. Network Functions Concept of Complex Frequency, Transform Impedances,Network function of one port and two port networks, Concept of poles and zeros, Relation between locations of poles. Time response and stability. Frequency response and bode plots. Interrelation between frequency response and convolution integral.

4. Two port networks, Two port parameters, Inter-conversion of 2 port parameter, network function- Driving point and transfer function, Inter-connections of 2 port networks, reciprocity ladder networks, Image impedance, Characteristic impedance, T-pi transformation and analysis.

5. Positive real functions and properties, synthesis of LC, RL and RC using Cauer and Fosters first and second form.

6. L-C filters-LPF, HPF, BPF and BRF type constant-k prototype filters; m-derived filters (principle only), Attenuators.

Recommended Books:

1. M.E. Valkenburg: Network Analysis
2.D.R. Choudhary: Network Analysis.
3.Narsingh Deo : Graph theory
4.W.H. Hayt & Jack E-Kemmerly, Engineering Circuit analysis" Tata McGrawHill.
5. Ram Kalyan, Linear Circuits Oxford University Press

Paper: MSEC104: Physics of Semiconductor Devices

Course outcome:

- **To learn the underlying physics of semiconductor devices**
- **To understand the working principle of semiconductor devices**

1. Basic Quantum Mechanics: The basic phenomena of the quantum physics and experimental background, particles and atomic models. Black-body radiation, line spectra, the photon, photoelectric effect, Compton dispersion. Bohr's atomic model. One-dimensional systems: The eigenvalue problem, stationary states, expectation values, operators. Particle in a box, the harmonic oscillator, transmission and reflection. Heisenberg's uncertainty relations, Quantum mechanical tunneling, Perturbation theory.

2. Semiconductors: Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility, Effect of temperature, Doping and high electric field.

3. Carrier Transport Phenomena: Conductivity, Mobility and Hall Effect, Diffusion and Drift of Excess Carriers, Generation and Recombination Mechanism, Trapping, Shockley–Read–Hall theory, Continuity and Diffusion Equation.

4. P-N Junction Diode: Built in potential barrier, Electric field, Space charge width of the Depletion region, Junction capacitance for an abrupt junction. Current Voltage Characteristics -Shockley diode equation, Equivalent circuit. Photo-Voltaic effect in pn junction, Junction Break down: I-V characteristics of Zener diode and Tunnel diode.

5. Bipolar Junction Transistor (BJT): Principle of operation, Basic current-voltage characteristics, Modes of operation, current gain, Device Modelling: Ebers-Mol model.
Junction Field Effect Transistor (JFET): Basic JFET operation, Device characteristics, Ideal DC current-voltage characteristics, Equivalent circuit of JFET and frequency limitations.

6. Metal semiconductor junction and MOSFET: Metal semiconductor junction, Schottky effect, Ohmic contacts, Heterojunction, 2DEG, HEMT, I-V and C-V characteristics.
MOSFET: Two terminal MOS structure, Basic MOSFET operation, Current voltage relationship.

Recommended Books:

1. Donald A. Neamen, “Semiconductor Physics and Devices Basic Principles”, 4th edn. McGraw-Hill, 2012

2. B.G. Streetman and Sanjay Banerjee, “Solid State Electronic Devices”, 7th edn., Prentice Hall, 2016.

3. S. M. Sze and K. K. Ng, “Physics of Semiconductor Devices”, 3rd edn. Wiley, 2007.

4. U. Mishra and J. Singh, “Semiconductor Device Physics and Design”, Springer, 2008.
5. J. H. Davies, “The Physics of Low Dimensional Semiconductors: An Introduction”, Cambridge University Press, 1998.
6. C. Lamberti and G. Agostini, “Characterization of semiconductor heterostructures and nanostructures”, Elsevier, 2013.

Paper: MSEC105

Course outcome:

- **To provide hands on training in handling instruments**
- **To train the students to design circuits and systems**

1. To study the characteristics of an All Pass Filter using Op-Amp.
2. To study the transfer characteristics of different passive networks and the phase transfer characteristics of a given two-port network (RC).
3. To study amplitude modulation
4. To study linear and nonlinear opamp circuits

Paper: MSEC106

Course outcome:

- **To provide hands on training in C/C++ language**
- **To train the students to solve problems in C/C++**

Numerical Analysis using C/C++

SEMESTER – II

Course outcome:

- **To learn the internal circuits of INTEGRATED CIRCUITS**
- **TO UNDERSTAND THE WORKING PRINCIPLE OF INTEGRATED CIRCUITS**

MSEC 201: Analog and Digital Integrated Circuits

1.IC Technology: Hybrid and monolithic IC; Semiconductor processing diffusion, implanation, oxidation, epitaxy, lithography; Si IC technology-MOS and Bipolar; Packaging and testing.

2. Analog Integrated Circuits. Differential amplifier, OP-AMP; continuous time filters, switched capacitance implementation of sample data filters; analog multiplexers.

Phase-Locked loops: Structure, equation, Acquisition and tracking range, frequency synthesizer.

3. Digital Integrated Circuits: Logic families – TTL, ECL, MOS, MESFET; design of combinational and sequential circuits – MUX, decoder/ encoder, registers, counters, gate arrays; programmable logic devices – PAL, GAL, PLA, Programmable gate arrays.

4. Application specific ICs: ICs for analog communication; Digital signal processing ICs; Speech and image processing.

5. Memories: Sequential and Random access memories; RAM bipolar and MOS static and dynamic memories; programmable memories PROM, EPROM, EEPROM.

Books Recommended:

1. Milman and Grable, Microelectronics. Tata MacGraw Hill.
2. Geiger, Allen and Strader – *VLSI – Design Techniques for Analog and Digital Circuits*.
3. Gray and Meyer – *Analysis and Design of Analog Integrated Circuits*.
4. A P Mathur – *Microprocessors.*
5. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2nd Ed.).
6. S Soelof – *Applications of Analog Integrated Circuits*.

MSEC 202: Digital Signal Processing

Course outcome:

- **To learn the underlying principle of Digital Signal Processing**
- **To understand the working principle of DSP hardware**

Introduction to signals and signal processing; continuous time signals and systems; discrete time signals and systems – sampling process; transform domain representation of signals and systems – LT, FT, DTFT, DFT, Z-transform.
Infinite impulse response digital filter design: DF from continuous time domain filters; impulse invariant transformation; mapping techniques; bilinear transformation; stability consideration; frequency transformation.
Finite impulse response digital filter deign: frequency response of linear phase filters; windowing techniques; some common windows; issues with windowing.
Frequency sampling technique: convolution and correlation.

DSP hardware: special purpose hardware for digital filtering and signal generation.
Arithmetic circuits: Fast address; fast multipliers/ dividers; delay blocks; DSP chips.
Specialized DSP circuits: digital resonators; DDFS circuits; ADC/ DAC circuits.
Applications of DSP algorithms in speech analysis and radar signal analysis.

Recommended Books:

1. J. G. Proakis and D. G Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson
2. A. V. Oppenheim and R. W. Schafer, "Digital Signal Processing", Pearson
3. S. K. Mitra, "Digital Signal Processing: A Computer based Approach", McGraw Hill
4. S. Salivhahanan, "Digital Signal Processing", McGraw Hill
5. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", PHI
6. M Hayes, "Digital Signal Processing", McGraw Hill
7. C. T. Chen, "Digital Signal Processing: Spectral Computation and Filter Design", Oxford University Press

MSEC 203: Analog communication Systems

Course outcome:

- **To learn about the theoretical background related to present day analog communication systems**

- **To become able to apply the knowledge in different analog transmission systems for analysis and design**

1. Communication System: Elements of communication System and its Fundamental limitations,. Need of Modulation. Random ProcessesRandom Process, Stationary Processes, Ergodic Processes, Transmission through LTI, Power spectral density, Gaussian process. NoiseExternal and internal sources of noise, Thermal noise, Calculation of thermal noise, Shot noise, Noise figure, Noise temperature, Equivalent noise bandwidth.

2. Amplitude (Linear Modulation): Generation and detection of DSB, SSB, VSB, Carrier Acquisition, Concept of FDM, AM transmitter and Receiver

3. Angle(Exponential Modulation)Types of Angle Modulation, Concepts of Instantaneous frequency,Wideband and Narrowband FM, Generation and detection of FM, Generation and detection of PM, FDM

4. Noise performance of CW Modulation SystemsNoise in DSB-SC, SSB-SC and AM system, Noise in FM and PM FM threshold and its extension, Pre-emphasis and De-emphasis in FM

5. Sampling theory & pulse modulationSampling process, sampling theorem, signal reconstruction, flat top sampling of band pass signals, Analog Pulse Modulation: Types of analog pulse modulation, Method of generation and detection of PAM, PWM, PPM, Spectra of pulse modulation, concept of time division multiplexing.

Recommended books:

1.Communication Systems S. Haykin, John Willy & Sons.

2.Communication Systems: A.B. Carlson, Mc-Graw-HW.

3.Modem Analog & Digital Communication Systems : B.P. Lathi; Oxford Univ. Press.

4. Taub, Herbert & Schilling, Donald L. / “Communication Systems” / Tata McGraw-Hill

5. Carlson, A. Bruce, Crilly, Paul B. & Rutledge, Janet C. / “Communication Systems an Introduction to Signals & Noise in Electrical Communication”/ Tata McGraw-Hill.

6.Kennedy, George & Davis, Bernard / “Electronic Communication Systems” / Tata McGraw-Hill / 4thEd.

MSEC 204: Microprocessor and Microcontrollers

Course outcome:

- **To learn about the basics of Microprocessor and Microcontrollers**
- **To become able to apply the knowledge in interfacing with instruments**

1. Introduction to Microprocessor: Evolution of Microprocessors, Register structure, ALU, Bus Organization, Timing and Control. Introduction to 8085: Architecture, Programming and Interfacing. Architecture of 16 bit and 32 bit Microprocessor: Internal organization of 8086, Bus interface unit, Execution unit, Register organization, Sequential memory organization, Bus cycle.

2. Assembly Language Programming:Addressing modes, Data transfer instructions, Arithmetical and logical instructions, Program control Instructions (jumps, conditional jumps and subroutine calls),Loop and string instructions, Assembler Directives. Parameter passing and recursive procedures.

3. CPU Module Design:Signal Description of pins of 8086 and 8088, Clock generation, Address and data bus Demultiplexing, Buffering memory organization, Read and Write cycle Timings, Interrupt structures, Minimum Mode CPU Module, Maximum Mode Operation (Coprocessor configuration) Features of Numeric processor 8087,Floating point representation, range resolution, normalization, representation of zero, unused codes, parity bit and error detection.

4. Basic of Interfacing:Programmed I/O, Interrupt driven I/O, DMA(8257), Parallel I/O (8255-PPI), Serial I/O(8251/8250, RS-232 standard) 8259 Programmable Interrupt Controller, 8237-DMA Controller, 8253/8254 Programmable Timer/Counter,(8279) Keyboard and display interface, ADC and DAC interfacing.

5. Memory Interfacing:Types of memory, RAM and ROM Interfacing with Timing consideration, DRAM Interfacing, Troubleshooting and Memory Module.

6. An Introduction to Microcontroller 8051 : The 8051 Architecture, Instruction set,Basic Assembly language programming concept.

7. Interfacing I/O Devices : Interfacing of keyboards, Display(using 8279), power devices, optical motor shaft encoders, ADCs & DACs to microcontrollers, microcontroller based scale.

8. Process control applications : Data Acquisition, temperature scanners, temperature controller, Flow control & level control, signature Analyzer using a logic analyzer for Trouble shooting. Sensors; System integration of sensors with microcontroller and Raspberry Pi; Sensor data - capture, transmission, storing and sharing; application

Recommended Books:

1.Douglas V.Hall/8086 Microprocessors Architecture

2.R.Gaonker/8085 Microprocessor

3.Kenneth J.Ayala/The 8051 Microcontroller/Penram International Publishing.

Paper: MSEC205

Experimental Laboratory

Course outcome:

- **To provide hands on training in handling instruments**
- **To train the students to design circuits and systems**

1. Study of the current mirror biasing and V_{BE} multiplier based voltage reference.
2. To draw the LDR characteristics at different intensities and to find out the "b" value and the dark resistance of the LDR.
3. Characteristics and Study of CE amplifier circuit (AC mode) with and without feedback.
4. To study the input and output voltage characteristics of Schmitt trigger circuit.
5. To study the operation of Pre-emphasis and De-emphasis circuits by plotting frequency response using Op-amp.
6. To study the characteristics of an Op-amp based RC-Phase-Shift Oscillator.

Paper: MSEC206

Course outcome:

- **To provide hands on training in python/scilab**
- **To train the students to solve problems in python/scilab**

Numerical Analysis using Python, Scilab

SEMESTER – III

MSEC 301: Digital Communication Systems

Course outcome:

- **To learn about the theoretical background related to present day digital communication systems**
- **To become able to apply the knowledge in different digital transmission systems for analysis, design and performance estimate**

1. Elements of Digital communication and information theory : Model of a digital communication system ; logarithmic measure of information, entropy and information rate, conditional entropy and redundancy, source coding fixed and variable length code words, Source coding theorem, prefix doing and craft inequality, Shannon – fano and Huffman coding for 1st , 2nd and 3rd order extensions, maximum entropy of a continuous source(with Gaussian distribution) entropy of a band limited white Gaussian noise, Mutual information and channel capacity of a discrete memory less channel, of a BSC, Hartley Shannon law.

2. Waveform coding techniques : Discretization in time and amplitude. Linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non – uniform quantizer, A law & μ law companding ;encoding and pulse code modulation, bandwidth of PCM, Differential pulse code modulation, Delta modulation, Idling noise and slope overload, Adaptive delta modulation, adaptive DPCM. Comparison of PCM and DM, MPEG audio coding standard. Digital multiplexing : Fundamentals of time division multiplexing, electronic commutator, bit, byte interleaving E1 Carrier system, Synchronization and signaling of E1, TDM, PCM hierarchy.

3. Digital Baseband transmission : line coding and its properties. NRZ & RZ types, signaling format for Unipolar, polar, bipolar, AMI & Manchester coding and their power spectra (No derivation), HDB and B&W signaling, ISI, Nyquist criterion for zero ISI & raised cosine spectrum. Matched filter receiver, derivation of its , impulse response and peak pulse signal to noise, correlation detector decision threshold and error probability for binary Unipolar (on – off), signaling.

4. Digital modulation techniques: Types of digital modulation, wave forms for amplitude, frequency and phase shift keying. Method of generation and detection of coherent & non – coherent binary ASK, FSK & PSK, differential phase shift keying, Quadrature modulation techniques (QPSK and MSK) probability of error and comparison of various digital modulation techniques.

5. Error control coding: Error free communication over a noisy channel, Hamming sphere, hamming distance and hamming bound, relation between minimum distance and error detecting and correcting capability, linear block codes, encoding & syndrome decoding ; cyclic codes, encoders and decoders forsystematic cycle codes ; convolutional codes, code tree & Trellis diagram, Viterbi and sequential decoding, burst error correction, comparison of performance.

Recommended Books:

1.P. Lathi/Modern Analog 86 Digital Communication/ Oxford Univ Press.

2.Simon Haykin /Digital Communication /John Wiley.

3. Simon Haykin/Communication Systems. John Wiley Qv Edn.

MSEC 302 Microwave devices and circuits

Course outcome:

- **Would have a skill on analysis, design and measurement of various microwave solid-state device-based systems**
- **Students would have an idea on microwave receiver design requirements**

A. RF and Microwave tubes:

Vacuum tube microwave device physics: Beam field interaction; power frequency limitation, device size limitations; special features of microwave tubes.

Non relativistic electron tubes: Parallel field type – Klystron, Reflex Klystron, Helix TWT, coupled cavity TWT, Twystrons; Crossed field type – magnetrons, FWCFA, carcinotron. Relativistic electron tubes: gyrotrons; free electron LASER.

RF and Microwave Devices: Diodes; high-frequency equivalent circuit; Schottky barrier diode; varactor diode; PIN diode; Applications.

Tunnel diodes; Impact ionization; IMPATT and other related diodes; small-signal analysis and model of IMPATT diode; TRAPATT; BARRITT.

Transferred electron devices; differential negative resistance and two-valley model of Gunn effect devices; modes of operation; waveguide cavity Gunn oscillator.

Three terminal devices; BJT, MESFET, MOSFET, HFET, HEMT – device physics, characteristics, model.

B. Network theorem at microwave frequencies; Foster's reactance theorem.

Transmission line theory: lumped element circuit model; the telegrapher equations; terminated lossless transmission line; generator and load mismatches; lossy transmission lines.

Microwave network analysis: the scattering matrix; the transmission matrix; ABCD matrix techniques; signal flow graph.

Smith chart: Impedance and admittance Smith chart; applications.

Waveguides; coaxial line; stripline; microstrip; wave velocities and dispersion; excitation of waveguides; coplanar waveguides; microstrip bends and discontinuities.

Impedance matching and tuning: matching with lumped elements; single-stub tuning; double stub tuning; the quarter wave transformer; theory of small reflections; binomial and

Chebyshev matching transformer; tapered lines; the Bode-Fano criterion.

MSEC 303: Advanced General Practical

Course outcome:

- **To provide hands on training in signal processing**
- **To train the students to design and simulation of antenna**

I. Signal Processing Lab

II. Antenna Simulation Lab

MSEC304: Electronic Science [to be opted by the students of other Departments]

Course outcome:

- **To provide students basic knowledge of electronic devices**
- **To make students aware about the modern communication systems**

Semiconductor Devices: Semiconductor physics, Formation of bands, pn junction physics- Fabrication steps; current-voltage characteristics; charge storage and transient behavior; junction breakdown
Characteristics of some semiconductor devices- BJT, JFET, MOSFET, MISFET, LED, Solar cell, Tunnel diode, Gunn diode.

Active Circuits: Amplifier circuits, voltage, current, and power amplifier.
Oscillators - Steady state operation of self-oscillator; RC and LC oscillators. Application of oscillators.

Op-Amp Based Circuits: Characteristics of ideal and practical op-amp; Basic operations using op-amps. ADC and DAC circuits; Op-amp based self oscillators: sinusoidal and relaxation oscillators.

Digital Circuits: Number systems, Logic functions; Logic simplification using Karnaugh maps; SOP and POS design of logic circuits; encoder and decoders.

Electronic Communication systems: Basic blocks of electronic communication systems, Concept of modulation, Analog and Digital, Introduction to radio, mobile and satellite communication (Basic principles).

Books Recommended:

8. J D Ryder, Electronics Fundamental and application, PHI
9. S.M. Sze, Physics of semiconductor devices.
10. Milman and Grable, Microelectronics. Tata MacGraw Hill.
11. B. C. Sarkar and S. Sarkar, Analog Electronics, Damodar Prakashani
12. B. C. Sarkar and S. Sarkar, Digital Electronics.
13. D. RoyChowdhuri and Jain, Analog integrated circuits, New age Publishers

MSEC305-1: VLSI Technology

Course outcome:

- **To impart knowledge on the VLSI design**
- **To apply the knowledge in electronics and communication**

Unit-I: Introduction: Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Computer-Aided Design Technology.

MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.

Unit-II: Fabrication of MOSFETs: Introduction, Fabrication Processes Flow – Basic Concepts, The CMOS n-Well Process, Layout Design Rules, Stick Diagrams, Full-Customs Mask Layout Design.

MOS Inverters – Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter.

Unit-III: Combinational MOS Logic Circuits: Introduction, MOS Logic Circuits with Depletion MOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates).

Unit – IV: Sequential MOS Logic Circuits: Introduction, Behaviour of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

Modelling of MOS Transistors using SPICE: Basic concept, The LEVEL 1, 2, and 3 Model Equations, State-of-the-Art MOSFET Models, Capacitance Models, Comparison of the SPICE MOSFET Models.

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, 3rd Edn., Tata McGraw-Hill Publishing Company Limited, 2003.

2. K. Eshraghian and N.H.E. Weste, “Principles of CMOS VLSI Design – a Systems Perspective”, 2nd Edn., Addison Wesley, 1993.

MSEC305-2: Medical Electronics

Course outcome:

- **To learn about the emerging field of medical electronics**
- **To apply the knowledge in medical field**

1. Excitable Tissue and Bioelectric Signals: Bioimpedance and Biopermittivity, Bioelectricity, Dielectrics –Introduction, Basic Biomaterials, Tissue-Conductivity, Special Electrical Properties, Cell Polarization, Action Potential, The Neuron, Axon Transmission, Receptors

2. Electrodes: Electrode pair, metals, Contact Electrolytes, Skin Preparation, Electrode double layer, DC Potentials, No Current Flow, Basic Experiment with DC Current Flo, Faraday's Law of Electrolysis, Electrode Polarization, Multiple Electrode System, Electrode Terminology, Electrode design-overview.

3. Biomedical Sensors and Signal conditioning: Introduction, Biopotential amplifiers –Basic requirements, Interferences, Special circuits,Isolation Amplifier and Patient Safety,Surge Protection, Input Guarding, Dynamic Range and Recovery

4. Instrumentation in Implantable Cardiac Pacemakers: Introduction, Indications, Pulse Generators, Block diagram and functional elements of pace makers, Leads, Programmers and Ongoing Follow-Up, System Operation,Performance and Reliability, Future of Pacing Technology

5. Basics of Cardiovascular Signal: The Physiological Basis of the Electrocardiogram: Cellular Processes that Underlie the ECG, The Physical Basis of Electrocardiography, The Normal Electrocardiogram, Introduction to Clinical Electrocardiography, Abnormal Patterns, The Normal Determinants of Heart Rate: The Autonomic Nervous System (Ectopy, Tachycardia, and Fibrillation), Conduction Blocks, Bradycardia, and Escape Rhythms, Cardiac Ischemia, Other Metabolic Disturbances, and Structural Abnormalities, A Basic Approach to ECG Analysis.

6. ECG Statistics, Noise, Artifacts, and Missing Data: Spectral and Cross-Spectral Analysis of the ECG, Extreme Low and High Frequency ECG, The Spectral Nature of Arrhythmias, Standard Clinical ECG Features, Non-stationarities in the ECG, Heart Rate Hysteresis, Arrhythmias, Arrhythmia Detection, Arrhythmia Classification from Beat Typing, Arrhythmia Classification from Power-Frequency Analysis, Arrhythmia Classification from Beat-to-Beat Statistics, Noise and Artifact in the ECG, Noise and Artifact Sources, Measuring Noise in the ECG, Heart Rate Variability, RR Interval Models, The Cardiovascular System, The DeBoer Model, Integral Pulse Frequency Modulation Model, Nonlinear Deterministic Models, RR Interval Models for Abnormal Rhythms, ECG Models, Pathophysiology Guided T-Wave Alternans Measurement,, ECG-Derived Respiratory Frequency Estimation, ST analysis.

7. Measurement, Conventional Electrode Positioning , Conditioning the Signals, Abnormal EEG Patterns, Ageing , Mental Disorders, Dementia , Epileptic Seizure and Non-epileptic Attacks, Psychiatric Disorders. External Effects

8. Neural Signal Analysis: Fundamentals of EEG Signal Processing, EEG Signal modeling, Linear Models , Nonlinear Modeling, Generating EEG Signals Based on modeling the Neuron al Activities, Nonlinearity of the Medium, Non-stationary, Signal Segmentation, Signal Transforms and Joint Time–Frequency Analysis, Wavelet Transform, Ambiguity Function and the Wigner–Ville Distribution

9. Event-Related Potentials: Detection, Separation, Localization, and Classification of P300 Signals, Using ICA, Estimating Single Brain Potential Components by modeling ERP Waveforms, Source Tracking, Localization of the ERP, Time–Frequency Domain Analysis, Adaptive Filtering Approach.

Recommended Books:

1. Advanced Methods and Tools for ECG Data Analysis, Francisco Azuaje, Gari D. Clifford, and Patrick E. McSharry, ISBN-13: 978-1580539661,

2. EEG Signal Processing, Saied Sanei and J A Chambers, John Wiely and Sons Limited, 2007.

3. Introduction to Electrophysilogical methods and instrumentation, Franclin Bretschneider and Jan R De Weille, ISBN 978-0-12-370588-4.

MSEC306-1: Satellite and Mobile Communications

Course outcome:

- **Students would become able to understand the working of various satellite-based communication systems**
- **Students would be familiarized with most current ideas like software defined radio and cognitive radio**

Wireless communication and network:
Evolution of wireless system; various impairments in wireless channels; modern wireless communication system; cellular concept; mobile radio signal propagation; modulation technique for wireless communication; equalization & diversity technique; coding technique for mobile communication; wireless network - WLAN, GSM, CDMA, GPRS, 3G & beyond.
Satellite communication:
Introduction; satellite orbit fundamentals; space segment and earth station; satellite links; multiple access schemes – FDMA, TDMA, CDMA, DAMA; packet radio – CSMA; ALOHA and slotted ALOHA.
Basic concepts:
OFDM, MIMO; software defined radio; cognitive radio; ultra wide band communication.
Recommended Books:
1. P. V. Sreekanth, Course in Digital Microwave Communication Systems, University Press
2. E. McCune, Practical Digital Wireless Signals, Cambridge University Press
3. J. G. Proakis, Digital Communications, McGraw-Hill

MSEC306-2: Nano Electronics

Course outcome:

- **Students would learn about several techniques of nano electronics**
- **Skill development in design of nano electronic circuits and systems**

Moore's Law: Transition from microelectronics to nanoelectronics; Importance of nanoelectronics
Nanostructure devices: resonant tunneling diode (RTD); its structure and derivation of I-V characteristics; RTD as microwave oscillator; single electron transistor (SET); Coulomb diamond structure; application of SERT, nanowire FETs; CNT transistor & and its RF circuit model
Quantum dots (QDs) as nanoelectronic circuit components; Quantum dots as electronic filters; circuit elements at optical frequencies nanoinductor, nanocapacitor and nanoresistor; core/ shell nano composites as nano-optical antenna; nano-optical Yagi-Uda antenna; nanostructure as the fourt basic passive circuit element 'memristor' – theory and applications

Properties of nanostructure: photocatalysis; dielectric properties, magnetic properties; optical properties; mechanical properties; electrical properties; surface effects and physical properties of nanoparticles

Nanophotonoic devices: Introduction to solar cells; different types of solar cell; thin-film solar cell; dye-sensitized solar cell; quantum dot solar cell; quantum dot dye-sensitized solar cell; effect of electrolyte; energy band diagram of quantum dot solar cell; efficiency; quantum dot LED (QLED); quantum dot photodetectors quantum dot laser

Carbon nanotube memory devices; CNT based resonator; nanomotors; graphene-based devices; nanomedicine; nanotechnology and environment

Modeling and simulation of nanodevices: Importance of measurement and estimation of electrical and optical properties of nanoparticles for device modeling; modeling and simulation of quantum dots and core-shell nanoparticles for application as nano-optical antenna; design of nano-optical Yagi-Uda antenna and study of its characteristics; modeling of nano-MOSFET and nano-MOS capacitor; modeling of Coulomb blockade effect for quantum dots; modeling and simulation of different properties of carbon nanotube

Recommended books:

1. Gworge W. Hanson, Fundamentals of Nanoelectronics, Pearson Education
2. Mitin, Kochelap and Stroscio, Introduction to nanoelectronics, Cambridge University Press

MSEC306-3: May be opted from SWAYAM

Paper: MSEC307 Community Engagement Activities

SEMESTER IV

MSEC401: Optical Fiber communication

Course outcome:

- **Would acquire knowledge on different standard optical communication system**
- **Would learn about different modulation techniques used in optical communication**

1. OVERVIEW OF OPTICAL FIBER COMMUNICATION: Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber, single mode fiber, cutoff wave length, mode filed diameter. Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers.

2. TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra modal dispersion, Intermodal dispersion.

3. OPTICAL SOURCES AND DETECTORS: Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Response time, double hetero junction structure, Photo diodes, comparison of photo detectors.

4. FIBER COUPLERS AND CONNECTORS: Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.

5. OPTICAL RECEIVER: Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver operation, Analog receivers.

6. ANALOG AND DIGITAL LINKS: Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links, microwave photonics.
Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single mode fibers, Power penalties, nodal noise and chirping.

7. WDM CONCEPTS AND COMPONENTS: WDM concepts, overview of WDM operation principles, WDM standards, Mach-Zehender interferometer, multiplexer, Isolators and circulators, direct thin film filters, active optical components, MEMS technology, variable optical attenuators, tunable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources.

8. OPTICAL AMPLIFIERS AND NETWORKS: optical amplifiers, basic applications and

types, semiconductor optical amplifiers, EDFA. Optical Networks: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides.

Recommended Books:

1. Optical Fiber Communication – Gerd Keiser, 4th Ed., MGH, 2008.
2. Optical Fiber Communications– – John M. Senior, Pearson Education. 3rd Impression,2007.
3. Fiber optic communication – Joseph C Palais: 4th Edition, Pearson Education.

MSEC402A: Power Electronics

Course outcome:

- **Students would learn about several techniques of power electronics**
- **Skill development in design of power electronic circuits and systems**

1. Power semiconductor Devices: Power semiconductor devices their symbols and static characteristics. Characteristics and specifications of switches, types of power electronic circuits. BJTO operation steady state and switch characteristics, switching limits. Operation and steady state characteristics of MOSFET and IGBT. Thyristor – Operation V- I characteristics, two transistor model, methods of turn-on Operation of GTO, MCT and TRIAC

2. Power Semiconductor Devices (Contd): Protection of devices. Series and parallel operation of thyristors, Commutation techniques of thyristor DC-DC Converters:Principles of step-down chopper, step down chopper with R-L load,Principle of step-up chopper, and operation with RL load, classification of choppers.

3. Phase Controlled Converters: Single phase half wave controlled, rectifier with resistive and inductive loads, effect of freewheeling diode. Single phase fully controlled and half controlled bridge converters. Performance Parameters, Three phase half wave converters, Three phase fully controlled and half controlled bridge converters, Effect of source impedance, Single phase and three phase dual converters. Resonant converters

4. AC Voltage Controllers: Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads. Three phase ac voltage controllers (various configurations and comparison), Single phase transformer tap changer. Cyclo-Converters, Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo-converters, output voltage equation

5. Inverters: Single phase series resonant inverter, Single phase bridge inverters, Three phase bridge inverters Voltage control of inverters, Harmonics reduction techniques, Single phase and three phase current source inverters.

Recommended Books:

1. M.H. Rashid,"Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition,2004.
2. M.D. Singh and K.B.Khanchandani, "Power Electronics"Tata MC Graw Hill, 2005
3. M.S. Jamil Asghar, "Power Electronics" Prentice Hall of India Ltd., 2004

MSEC402B: Control systems

Course outcome:

- **Students would learn about several techniques of control systems**
- **Skill development in control systems**

1. Input/output relationship: Introduction to open loop and closed loop control systems. Mathematical representation of physical systems. Transfer functions block diagram and signal flow graph. Reduction algebra, masons gain. Time domain performance criterion, Transient response of first order, second order & Higher Order Systems.

2. Error analysis: Static and Dynamic error coefficients. Ersor criterion, frequency Domain analysis polar and inverse polar plots, bode plot, Frequency domain specifications. Relative stability gain margin and phase margin, correlation with time domain, W & N circles.

3. Stability theory: concept of stability, asymptotic & Conditional stability, Routh Hurwitz criterion, Nyquist stability criterion, Liapunova's Direct Method, Root Locus plots.

4. Compensation Techniques: Concept Lag and Lead & lag lead Networks, Design of closed loop Systems Using compensation Techniques.

5. State Space Analysis of Control Systems: State Space Representation, Solution to Homogeneous State Equation, State Transition Matrix, Time Invariant State Equations, linear time varying systems, Controllability and Observability, Vandermonde Matrix, Decomposition of Transfer Function.

6. Non Linear Systems:Introduction, Some Common Types of Non-Linearities,Classification of Non-Linearity,Study of Non-Linear Systems, Describing Function method of Analysis, Phase Plane Analysis, Stability Analysis with Describing Functions.

Recommended Books:

1.KUO B.CI Automatic control system/Pill.
2.Ogata Kj Modern Control Engineering / PHI.
3.Nagrath I.J. & Gopal, M/Control Systems Engineering/New Age International.

Paper: MSEC403

Advanced General Practical

Course outcome:

- **To provide hands on training in signal processing**
- **To train the students to design and simulation of antenna**

I. communication lab

II. Simulation Lab

MSEC404-1: Photonics

Course outcome:

- **Students would learn about several techniques of photonics**
- **Skill development in design of photonic systems**

Introduction: Importance of photonics in electronics and communication; review of electromagnetic theory of light; ray optics; wave optics; beam optics; physics of thin-film optical devices – anti-reflection coating; beam splitter; spectral filters; CD-ROMs etc

Quantum electronics and statistical optics: photons and atoms – spontaneous emission; abruption; stimulated emission; Einstein coefficient; theory of oscillation; pumping schemes; rate equations; characteristics of laser output; line shape functions; line broadening; laser mode selection; laser cooling and trapping of atoms; hole burning; case studies of He-Ne, Ar, CO_2, ruby, Nd-Yag; X-ray lasers; pulse lasers – Q-switching; mode locked laser; ultrafast laser; case studies of industrial and scientific applications of laser; statistical optics – statistical properties of random light waves; partially coherent light waves and partial polarization

Fourier optics and holography: review of Fourier transform; two-dimensional Fourier transform and convolutions in optics; Fraunhofer diffraction; Fourier transform properties of lens types of hologram; physics of information recording and reconstruction with hologram; application of holography in microscopy; interferometry; character recognition; quantitative theory of spatial frequency filtering and its applications

Electro-optic, acousto-optic, and magneto-optic effects: review of polarization and crystal optics; principle of elctro-optics – Pockel and Kerr effects; scanner; directional coupler; spatial light modulators; electro-optics of anisotropic materials; liquid crystals; photorefractive materials; Interaction of light with sound – Bragg diffraction of beam; coupled wave theory; acousto-optic modulator, scanner, filter, frequency shifter and isolator; acousto-optics of anisotropic media; basic idea of magneto-optic effect; photonic switching and computing – photonic switch based on electro-optic; acousto-optic effects and magneto-optic effects; all optical switch; bistable switch; optical interconnects and computing

Nonlinear optics and nano-photonics: nonlinear optical media; second and third order nonlinear optical effects – wave mixing and conjugation; coupled wave theory; anisotropic and dispersive nonlinear media; optical solitons; nanoparticles; quantum dots; quantum wells; lasers and LED based on quantum dots and quantum wells; photonic crystals (PhC) – basic principles, PhC beam splitter, power combiner, resonator; photonic crystal based fibers as waveguides; negative refractive index based materials; surface plasmon resonance; basic components and devices for integrated optics

Biophotonics: Photobiology; light-matter interaction; biosensors, bioimaging techniques; fluorescence microscopy; confocal microscopy; optical tomography; single-photon and multi-photon microscopy; terahertz spectroscopy and imaging

Recommended books:

1. B. E. A Saleh and M. C. Teich, Fundamentals of Photonics, Wiley Interscience
2. E. R. Pike and R. G. W. Brown, Principles of Nanophotonics, Taylor and Francis
3. J. D. Joannopolous et. al, Photonic Crystal, Princeton University Press
4. K. Iga, Y Kokobun, Integrated Optics, Taylor and Francis

MSEC404-2: Digital Image Processing

Course outcome:

- **Students would learn about several techniques of digital image processing**
- **Skill development in image processing**

1. Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.

2. Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian.

3. Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering.

4. Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections.

5. Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT

implementation using FFT, Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation

6. Wavelet based Compression: Expansion of functions, Multi-resolution Image analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking.

7. Morphological Image Processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

8. Image Segmentation: Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Regionbased segmentation, Watershed algorithm, Use of motion in segmentation.

Recommended Books:

1. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education.

MSEC405-1: Radar, Remote Sensing and Navigational Systems

Course outcome:

- **Students would gain the skill on radar engineering**
- **Would have an idea of microwave and IR remote sensing and GIS**
- **Would have a knowledge of theoretical as well as practical expertise on satellite-based navigation systems**

Radar:
Introduction; basic radar range equation and modification; CW, FM and pulsed radar; MTI and pulsed Doppler radars; scanning and tracking radars; receiver; duplexer; display systems; ambiguity diagram; pulse compression; radar antennas; ECM and ECCM .
Remote sensing:
Overview; earth's atmosphere; land surface; oceans; land and sea ice; radiation budget; climate; radar altimeters; synthetic aperture radars (SAR); wind scatterometers; multispectral imaging; IR and microwave radiometers; concept of GIS.
Satellite based navigational systems:
Electronic navigation systems – global and regional; concepts of satellite based navigation systems – GPS, GLONASS, Galileo, Beidou, QZSS, NaVIC; code and carrier phase based measurement techniques; augmentation; relative positioning – DGPS, RTK; Precise Point Positioning (PPP); Satnav applications.
Recommended Books:

1. M. Skolnik, “Introduction to Radar Systems”, McGraw Hill
2. P. Z. Peebles, “Radar Principles”, Wiley
3. E. F. Nathanson, “Radar Design Principles: Signal Processing and the Environment”, PHI
4. M. A. Richards, “Fundamentals of Radar Signal Processings”, McGraw Hill
5. G. Joseph and C. Jeganathan, “Fundamentals of Remote Sensing”, Universities Press
6. B. C. Panda, “Remote Sensing: Principle and Applications”, Viva Books
7. I. H. Woodhouse, “Introduction to Microwave Remote Sensing”, CRC Press
8. P. J. G. Teunissen and O. Montenbruck (Eds) “Springer handbook of global navigation satellite systems”, Springer
9. P. Misra and P. Enge “Global Positioning System: Signals, Measurements and Performance Revised”, Ganga-Jamuna Press.
10. E. D. Kaplan and C. J. Hegarty, “Understand

MSEC405-2: Antenna Design

Course outcome:

- **To learn about the basic analytical techniques in antenna engineering**
- **Expertise on analysis, design, simulation, fabrication and measurement of different antenna**

Review of antenna parameters; theorems; and other fundamental issues
Miniaturization and bandwidth enhancement; Broad band dipole and matching technique; traveling wave and broad band antenna; frequency independent antenna; planar broad band antennas; UWB antenna
Compact antenna
Smart Antenna – benefits; types; fixed & switched beam antenna system; adaptive array system; analog and digital beamforming; multiple antenna design; combining techniques; diversity, multi beam formation; MIMO
Active antenna array

Recommended Books:
1. C.A. Balanis, “Antenna Theory: Analysis and Design’, Wiley
2. J.D Kraus, R. J. Marhefka and A. Khan, Antennas and Wave Propagation, MGH
3. R. S. Elliot, “Antenna Theory and Design”, Wiley
4. J. R. James and P. S. Hall, “Handbook of Microstrip Antenna”, Peter Peregrinous Ltd
5. R. Garg, P.Bhartia, I. Bhal and A. Ittipiboon, “Microstrip Antenna Design Handbook”, Artech House
6. G. Kumar and K.P. Ray, Broad Band Microstrip Antennas, Artech House

Paper: MSEC406

Project/Term Paper

The project work or term paper in experimental/theoretical area should be designed in such a way that it acts as a bridge between pass out PG students and PhD incumbents.