Indian Institute of Information Technology Manipur

B.Tech Electronics and Communication Engineering

Course Syllabi Semesters I - IV

EC101	Digital Design	3-1-0-8

Syllabus:

Binary Arithmetic: Representation of integers, fractions and signed numbers in different codes; Addition and subtraction operations on binary-coded numbers; Algorithms for performing multiplication and division.

Combinational Circuits: Boolean expressions and their minimization using algebraic identities; Karnaugh map representation and minimization of Boolean functions using K-map; Two-level realizations using gates -- AND-OR, OR-AND, NAND-NAND and NOR-NOR structures.

Combinational Circuits using MSI Modules: Multifunction gates, Multi-bit adder, Multiplexers, Demultiplexers, Decoders, Programmable ALU; Multiplexer-based realization of K-maps; Combinational circuit design using multiplexers and gates.

Sequential Circuits: Latches and Flip-flops; Ripple counters using T flip-flops; Synchronous counters; Shift Registers; Ring and MLS counters; Sequence generator using J-K / D flip-flops.

Memories, Microprocessors and Microcomputer Organization: RAM, ROM, PAL, PLA, Introduction to microprocessor and microcomputer organization; Central processing unit (CPU), memory and input/output devices.

Texts:

1. M. Morris Mano, Digital Logic and Computer Design, 11th Edition, Pearson Education, 2009.
2. R. S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085

References:

1. Ronald J Tocci, Neal S Wisdmer and Gregory L. Moss, Digital Systems: Principle and Applications, 10th Edition, Pearson Education, 2011.
2. Albert Paul Malvino, Donald P Leach and Gautam Saha, Digital Principles and Applications 7th Edition, Tata McGraw - Hill Education, 2011.

EC110	Digital Design Lab	0-0-3-3

- Familiarization with digital IC family 74LS00 and 74HS00. Familiarization with laboratory equipments – voltage generator, function generator, oscilloscope. Study of digital IC characteristics – input voltage, input current, output voltage, output current, fan out, noise margin and propagation delay.
- Study of combinational logic circuits (selective)
  - Half adder, half subtracter, full adder, full subtracter, binary adder-subtracter
  - Implementation of Boolean functions using logic gates and study of Boolean function characteristics, like turn around time.
  - Implementation of Multiplexers, Demultiplexers, Encoders, Decoders (selective)
  - Implementation of Boolean functions using Multiplexers/Decoders, Implementation of higher order multiplexers/decoders using lower order multiplexers/decoders
  - Binary to BCD code conversion and vice-versa
- Study of sequential logic circuits (selective)
  - Implementation of flip-flops, master-slave flip-flops, edge-triggered flip-flops. Study of flip flop characteristics, observation of timing diagram in oscilloscope with respect to clock input.

- Implementation of binary register circuits and study the register characteristics as data storage.
- Implementation of binary counters
- Implementation of sequence generators/ serial adders

EC102	**Electrical Circuit Analysis**	**3-1-0-8**

Syllabus:

Basic components and electric circuits: charge, current, voltage and power, voltage and current sources, Ohm's law; Voltage and current laws: nodes, paths, loops and branches, Kirchoff's current law, Kirchoff's voltage law, independent sources, voltage and current division; Basic nodal and mesh analysis: nodal analysis, supernode, mesh analysis, supermesh; Network theorems: linearity and superposition, source transformations, Thevenin and Norton equivalent circuits, maximum power transfer; RL and RC circuits: source-free RL circuit, source-free RC circuit, unit-step function, driven RL circuits, natural and forced response, driven RC circuits; RLC circuit: source-free parallel circuit, overdamped parallel RLC circuit, critical damping, underdamped parallel RLC circuit, source-free series RLC circuit, complete response of the RLC circuit; Sinusoidal steady-state analysis: forced response to sinusoidal functions, complex forcing function, phasor, phasor relationship for R, L and C, impedance, admittance, phasor diagrams, instantaneous power, average power, apparent power and power factor, complex power; Polyphase circuits: polyphase systems, single-phase three-wire systems, three-phase Y-Y connection, delta connection, power measurement in three-phase systems; Magnetically coupled circuits: mutual inductance, energy considerations, linear transformer, ideal transformer; Frequency response: parallel and series resonance, Bode plots, Filters; Two-port networks: one-port networks, admittance parameters, impedance parameters, hybrid parameters, transmission parameters.

Texts:

1. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata-McGraw-Hill Publishing Company Limited, 7th / 8th Edition, 2010/ 2012.

References:

1. A. Bruce Carlson, Circuits: Engineering Concepts and Analysis of Linear Electric Circuits, 2nd Reprint, Thomson Asia Pvt. Ltd., 2006.
2. R. A. De Carlo and P. M. Lin, Linear Circuit Analysis, 2nd Edition, Oxford University Press, 2001.

EC103	**Basic Electronic Circuits**	**3-1-0-8**

Objective - After pursuing this course the students shall be able to: 1. develop simple electronic circuits, 2. analyze the behavior of basic electronic circuits, 3. use operational amplifiers as basic building blocks of analog electronic circuits

Course Topics - Examples of Electronic Systems: Music System, Radio, Television,

D-C power supply: Diode characteristics, half-wave and full wave rectifiers, shunt capacitor filter, voltage regulator, regulated D-C power supply.

Amplifier: Amplifier parameters, controlled source models, classification, the operational amplifier (OP-AMP) as a linear active device, the VCVS model of an op-amp, different amplifier configurations using op-amp, frequency response of op-amp and op-amp based amplifiers.

Filter: Concepts of low-pass, high-pass and band-pass filters, ideal (brick-wall) filter response, frequency response of simple RC filters, active RC filters using Op-amp.

Oscillator: Effects of negative and positive feedback of an amplifier, condition of harmonic oscillation, RC and LC oscillator circuits.

Comparator: Op-amp as a comparator, digital inverters (TTL/CMOS) as comparators, comparator with hysteresis, Schmitt trigger using Op-amp, 555 timer as a two dimensional comparator.

Waveform generators: Concept of bistable, monostable and astable circuits, timer and relaxation oscillator based on comparator and RC timing circuit, square wave generator using 555 timer, crystal clock generator.

Analog-Digital conversion: Digital to Analog Converter (DAC) using binary resistor scheme, R-2R ladder DAC, DAC using switched current resources, Analog to Digital converter (ADC) using capacitor charge/discharge: single-slope and dual-slope ADCs, ADC using counter and DAC, ADC using successive approximation.

Outcome - As a result of this course students become acquainted with basics of electronic circuits at least at the system integration level.

Texts:

1. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits, International Version 6th Edition, 2013, Oxford University Press India

EC111	**Basic Electronics Lab**	**0-0-3-3**
Experiments using diodes: diode characteristics, design and analysis of half-wave and full-wave rectifier circuits without and with filter, clipping circuits, clamper circuits, experiments using operational amplifier: inverting amplifier, non-inverting amplifier, voltage follower, integrator, differentiator, comparators, Multivibrators, Wien's Bridge Oscillator, first-order filters, D/A and A/D converters.		

EC241	**Signals and Systems**	**3-0-0-6**

Syllabus: Signals: Signal Basics, Elementary signals, classification of signals; signal operations: scaling, shifting and inversion; signal properties: symmetry, periodicity and absolute integrability; Sampling and Reconstruction, Sampling and Nyquist theorem, aliasing, signal reconstruction: ideal interpolator, zero-order hold, first-order hold; Sinc function, Practical reconstruction.

Systems: classification of systems; Time-Domain Analysis of Continuous-Time Systems; system properties: linearity, time/shift-invariance, causality, stability; continuous-time linear time invariant (LTI) and discrete-time linear shift invariant (LSI) systems: impulse response and step response; response to an arbitrary input: convolution; circular convolution; system representation using differential equations; Eigen functions of LTI/ LSI systems, frequency response and its relation to the impulse response.

Signal representation: signal space and orthogonal basis; continuous-time Fourier series and its properties; continuous-time Fourier transform and its properties; Parseval's relation, time-bandwidth product; discrete time fourier series; discrete-time Fourier transform and its properties; relations among various Fourier representations. Linear Convolution using DFT. Fast Fourier Transform (FFT); Laplace transform and properties, Inverse Laplace Transform by Partial Fraction and Z-transform: definition, region of convergence, properties; transform-domain analysis of LTI/LSI systems, system function: poles and zeros; stability, inverse Z-Transform by Partial Fraction.

Text:

1. M. J. Roberts, "Fundamentals of Signals and Systems", Tata McGraw Hill, 2007.

References :

1. A.V. Oppenheim, A.S. Willsky and H.S. Nawab, "Signals and Systems", Prentice Hall of India, 2006.

2. B. P. Lathi,"Signal Processing and Linear Systems", Oxford University Press, 1998.
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4/e, Prentice Hall, 1998.
4. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons, 1998.

EC242	Signals and Systems Lab	0-0-3-3

Generate and execute MATLAB programs: basic continuous and discrete time signals, convolution of two sequences using: overlap and save method, overlap and add method. Circular convolution with zero padding. Auto correlation of a sequence and cross correlation of two sequences. Finding the response of the given system. Program to determine the Fourier coefficients. Program to compute the Fourier series. Program to compute the Fourier transform, Fourier spectrum. Laplace transform, poles/zeros. Mat lab program to find the DFT, Z-transform, DTFT, convolution using DTFT.

EC201	Analog Circuits	3-1-0-8

Syllabus: Review of working of BJT, JFET and MOSFET and their small signal equivalent circuits both for low and high frequencies; Different types of biasing for BJT and MOSFET, Bias Compensation, Thermal Stabilization; Single stage amplifiers CE-CB-CC and CS-CG-CD; Multistage amplifiers: RC Coupled, Transformer Coupled, Direct Coupled amplifier and their frequency responses; Differential amplifiers: DC and small signal analysis, CMRR, current mirrors, active load and cascade configurations, frequency response; case study: 741 op-amp – DC and small signal analysis, frequency response, frequency compensation, GBW, phase margin, slew rate, offsets; Feedback amplifiers: basic feedback topologies and their properties, analysis of practical feedback amplifiers, stability; Power Amplifiers: class A, B, AB, C, D, E stages, output stages, short circuit protection, power transistors and thermal design considerations, Tuned Amplifier; Filter: filter approximations: Butterworth, Chebyshev and elliptic, first order and second order passive/active filter realizations.

Text:

1. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits, International Version 6th Edition, 2013, Oxford University Press India.

References:

1. P. Gray, P. Hurst, S. Lewis and R. Meyer, Analysis & Design of Analog Integrated Circuits, 5/e, Wiley, 2009.
2. Millman , Halkias, Parikh – Integrated Electronics, 2/e, Penguin Books Ltd, 2009.
3. Sergio Franco - Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, McGraw Hill Book Company, 2001.

EC202	Analog Circuits Lab	0-0-3-3

Experiments using BJTs: BJT characteristics in different configurations, hybrid parameters, single-stage and multistage BJT amplifiers, effect of negative feedback; experiments using FETs: FET characteristics, FET amplifiers; current mirror, differential amplifier, filters, voltage regulators.

EC251	Principles of Communication	3-1-0-8

Syllabus Basic blocks in a communication system: transmitter, channel and receiver; baseband and passband signals and their representations; concept of modulation and demodulation. Continuous wave (CW) modulation: amplitude modulation (AM) - double sideband (DSB), double sideband suppressed carrier (DSBSC), single sideband suppressed carrier (SSBSC) and vestigial sideband (VSB) modulation; angle modulation - phase modulation (PM)

& frequency modulation (FM); narrow and wideband FM. AM transmitter – Broadcast transmitters – SSB transmitter – Radio telegraphy transmitter – FM transmitter – Tuned radio frequency and super heterodyne receivers – AM broadcast receiver – SSB receivers – Diversity reception – FM receivers.

Pulse Modulation: sampling process; pulse amplitude modulation (PAM); pulse width modulation (PWM); pulse position modulation (PPM) ; pulse code modulation (PCM); line coding; differential pulse code modulation; delta modulation; adaptive delta modulation. Noise in CW and pulse modulation systems: Receiver model; signal to noise ratio (SNR); noise figure; noise temperature; noise in DSB-SC, SSB, AM & FM receivers; pre-emphasis and de-emphasis, noise consideration in PAM and PCM systems. Basic digital modulation schemes: Phase shift keying (PSK), amplitude shift keying (ASK), frequency shift keying (FSK) and Quadrature amplitude modulation (QAM); coherent demodulation and detection; probability of error in PSK, ASK, FSK & QAM schemes. Multiplexing schemes: frequency division multiplexing; time division multiplexing.

Text:

1. J. G. Proakis and M. Salehi, Communication system engineering, 2/e, Pearson Education Asia, 2002.
2. R. E. Ziemer, W. H. Tranter, Principles of Communications: Systems, Modulation, and Noise, 5/e, John Wiley & Sons, 2001.

References :

1. Simon Haykin, Communication Systems, 4/e, John Wiley & Sons, 2001.
2. K. Sam Shanmugam, Digital and Analog Communication Systems, John Wiley and Sons, 1979.
3. A. B. Carlson, Communication Systems,3/e, McGraw Hill, 1986.
4. B. P. Lathi, Modern Analog and Digital Communication systems, 3/e, Oxford University Press, 1998.
5. H. Taub and D. L. Schilling, Principles of Communication Systems, 2/e, McGraw Hill, 1986.

EC252	**Communications Laboratory**	**0-0-3-3**

Experiments on Breadboard:

Implementing the switching function using with the help of diode based ring modulator: AM generation. Demodulation of AM signal using envelope detector.

To generate a conventional AM signal using multiplier chip AD633. To design and implement an envelope detector for appropriate demodulation of AM signal.

FM generation using IC555. Demodulation using slope detector.

Generation of PAM signal. Reconstruction of PAM signal. Generation of PWM and PPM signals. Demodulation of PWM signals.

Experiments on MATLAB:

Generation of AM signal and demodulation of AM signal using MATLAB. Understanding Signal correlation, Autocorrelation, Cross correlation of signals using MATLAB. Finding the power spectral density of signals using MATLAB

Generation and demodulation of FM signals using MATLAB. Generation and Demodulation of DSB-SC modulation. Generation and Demodulation of SSB-SC Modulation. Generation and demodulation of PAM, PPM, PWM waveforms.

QAM modulation. Mat lab program for Communication receiver and BER performance. MATLAB program for generating RZ, NRZ, Manchester codes.

EC243 | **Digital Signal Processing** | **3-0-0-6**

Syllabus :

Review of discrete time signals, systems and transforms: Discrete time signals, systems and their classification, analysis of discrete time LTI systems: impulse response, difference equation, frequency response, transfer function, DTFT, DTFS and Z-transform.

Frequency selective filters: Ideal filter characteristics, lowpass, highpass, bandpass and bandstop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems.

Structures for discrete-time systems: Signal flow graph representation, basic structures for FIR and IIR systems (direct, parallel, cascade and polyphase forms), transposition theorem, ladder and lattice structures.

Design of FIR and IIR filters: Design of FIR filters using windows, frequency sampling, Remez algorithm and least mean square error methods; Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations.

Discrete Fourier Transform (DFT): Computational problem, DFT relations, DFT properties, fast Fourier transform (FFT) algorithms (radix-2, decimation-in-time, decimation-in-frequency), Goertzel algorithm, linear convolution using DFT. Multi-dimensional DFT (M-D DFT) and its computation.

Finite wordlength effects in digital filters: Fixed and floating point representation of numbers, quantization noise in signal representations, finite word-length effects in coefficient representation, roundoff noise, SQNR computation and limit cycle.

Introduction to multirate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding. Applications of multi-rate filters in signal processing and communication. Adaptive digital filters and their applications. Introduction to wavelet transform and its applications. Case studies of applications of DSP: Applications in audio, medical and communication.

Text:

1. A. V. Oppenheim and R. W. Shafer: Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
2. J. G. Proakis and D. G. Manolakis: Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007.
3. E. Ifeachor and B. Jervis: Digital Signal Processing, Pearson, 2/e, 2006.

References :

1. V.K. Ingle and J.G. Proakis, “Digital signal processing with MATLAB”, Cengage, 2008.
2. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, Tata McGraw Hill, 2006.
3. T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore, 2004.
4. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall India, 2005.
5. A. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McGraw-Hill, New Delhi, 2003.
6. T. J. Cavicchi, Digital Signal Processing, John Wiley and Sons, Inc., Singapore, 2002.

EC244	Digital Signal Processing Lab	0-0-3-3

List of Experiments:

1. Generation of signals – (i) ramp signals at different sampling frequencies, (ii) sinusoid signals, (iii) multi-toned sinusoid signals, (iv) pseudo random noise sequence.
2. echo generation using three different delay.
3. Generation of AM and FM signals.
4. Application of mean filtering on a noisy sinusoid.
5. Application of autocorrelation function to generate sinusoid from a noisy signal.
6. Design of filters, IIR filter and FIR filter.

EC260	Semiconductor Devices	3-0-0-6

Objective: Understanding the physics behind building blocks of electronic circuits, viz. diodes, BJTs and MOSFETs.

Contents: *Brief discussion of quantum theory of solids* – energy bands, electrical conduction in solids, formation of Fermi-Dirac probability function using the concepts of statistical mechanics and k-space diagram. *Semiconductors in equilibrium* – charge carrier profile in intrinsic and extrinsic semiconductor, behavior of Fermi energy level with varying temperature and doping concentration. *Carrier transport in semiconductors* – drift current and diffusion current, Hall Effect. *Semiconductors in non-equilibrium condition* – carrier generation and recombination, continuity equation, ambipolar transport. *p-n junction* under zero applied bias and reverse bias, comparative study of abrupt junction and linearly graded junction, qualitative and quantitative discussion of p-n junction current, small signal model of p-n junction, junction breakdown and Tunnel diode. *Behavior of metal semiconductor junction*, Schottky barrier diode, metal-semiconductor ohmic contact. *Bipolar transistor* - basic principles of operation, carrier distribution under different modes of operation, non-ideal effects, frequency limitations. *Fundamentals of MOSFET*, capacitance-voltage characteristics, current voltage relationship, frequency limitations.

Text:

1. Donald A. Neamen, Semiconductor Physics and Devices, Tata McGraw Hill, 3rd Edition, 2007

References :

1. Ben G. Streetman, Solid State Electronic Devices, PHI, 5/e, 2001.
2. J. Singh, Semiconductor Devices - Basic Principles; John Wiley & Sons Inc., 2001.
3. Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, Wiley, 3/e, 2006/7.

Mathematics

Course Syllabi Semesters I – IV

MA101	Mathematics I	3-1-0-8

Syllabus

Linear Algebra: Systems of linear equations and their solutions; vector space R^n and its subspaces; spanning set and linear independence; matrices, inverse and determinant; range space and rank, null space and nullity, eigenvalues and eigenvectors; diagonalization of matrices; similarity; inner product, Gram-Schmidt process; vector spaces (over the field of real and complex numbers), linear transformations.

Single Variable Calculus: Convergence of sequences and series of real numbers; continuity of functions; differentiability, Rolle's theorem, mean value theorem, Taylor's theorem; power series; Riemann integration, fundamental theorem of calculus, improper integrals; application to length, area, volume and surface area of revolution.

Texts:

1. **G. Strang**, *Linear Algebra and Its Applications*, 4th Edition (South Asian Edition), Wellesley-Cambridge Press, 2009 (ISBN: 9788175968110).
2. **S. R. Ghorpade** and **B. V. Limaye**, *An Introduction to Calculus and Real Analysis*, Springer India, 2006 (ISBN: 9788181284853).

References:

1. **D. Poole**, *Linear Algebra: A Modern Introduction*, 2nd Edition, Brooks/Cole, 2005.
2. **K. Hoffman** and **R. Kunze**, *Linear Algebra*, 2nd Edition, Prentice Hall India, 2009 (ISBN: 9788120302709).
3. **R. G. Bartle** and **D. R. Sherbert**, *Introduction to Real Analysis*, 3rd Edition, Wiley India, 2007 (ISBN: 9788126511099).

MA102	**Mathematics II**	**3-1-0-8**

Syllabus

Multi Variable Calculus: Vector functions of one variable – continuity, differentiation and integration; functions of several variables - continuity, partial derivatives, directional derivatives, gradient, differentiability, chain rule; tangent planes and normals, maxima and minima, Lagrange multiplier method; repeated and multiple integrals with applications to volume, surface area, moments of inertia, change of variables; vector fields, line and surface integrals; Green's, Gauss' and Stokes' theorems and their applications.

Ordinary Differential Equations: First order differential equations - exact differential equations, integrating factors, Bernoulli equations, existence and uniqueness theorem, applications; higher-order linear differential equations - solutions of homogeneous and non-homogeneous equations, method of variation of parameters, series solutions of linear differential equations, Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kinds. Laplace and inverse Laplace transforms; properties, convolutions; solution of ODE by Laplace transform. Systems of first-order equations, two-dimensional linear autonomous system, phase plane, critical points, stability.

Texts:

1. **G. B. Thomas, Jr.** and **R. L. Finney**, *Calculus and Analytic Geometry*, 9th Edition, Pearson Education India, 1996.
2. **S. L. Ross**, *Differential Equations*, 3rd Edition, Wiley India, 1984.

References:

1. **H. Anton**, **I. C. Bivens** and **S. Davis**, *Calculus*, 10th Edition, Wiley, 2011.
2. **T. M. Apostol**, *Calculus*, Volume 2, 2nd Edition, Wiley India, 2003.
3. **W. E. Boyce** and **R. C. Di Prima**, *Elementary Differential Equations and Boundary Value Problems*, 9th Edition, Wiley India, 2009.
4. **E. A. Coddington**, *An Introduction to Ordinary Differential Equations*, Prentice Hall India, 1995.

MA203	Mathematics III	3-0-0-6

Syllabus

Introduction to probability: mathematical background - sets, set operations, sigma and Borel fields; classical, relative-frequency and axiomatic definitions of probability; conditional probability, independence, total probability, Bayes rule; repeated trials;

Random variables: cumulative distribution function, continuous, discrete and mixed random variables, probability mass function, probability density functions; functions of a random variable; expectation - mean, variance and moments; characteristic and moment-generating functions; Chebyshev, Markov and Chernoff bounds; special random variables-Bernoulli, binomial, Poisson, uniform, Gaussian and Rayleigh; joint distribution and density functions; Bayes rule for continuous and mixed random variables; joint moments, conditional expectation; covariance and correlation- independent, uncorrelated and orthogonal random variables; function of two random variables; sum of two independent random variables; random vector- mean vector and covariance matrix, multivariate Gaussian distribution; Vector-space representation of Random variables, laws of large numbers, central limit theorem;

Random process: discrete and continuous time processes; probabilistic structure of a random process; mean, autocorrelation and autocovariance functions; stationarity- strict-sense stationary and wide-sense stationary (WSS) processes: autocorrelation and cross-correlation functions; time averages and ergodicity; spectral representation of a real WSS process-power spectral density, cross-power spectral density, Wiener Khinchin theorem, linear time-invariant systems with WSS process as an input- time and frequency domain analyses; spectral factorization theorem;

Examples of random processes: white noise, Gaussian, Poisson and Markov processes, Basics of Queuing Theory, Characteristics of queuing systems.

Texts:

1. **Papoulis and S.U. Pillai**, *Probability Random Variables and Stochastic Processes, 4/e, McGraw-Hill, 2002.*
2. **A. Leon Garcia**, *Probability and Random Processes for Electrical Engineering, 2/e, Addison-Wesley, 1993.*

References:

1. **H. Stark and J.W. Woods**, *Probability and Random Processes with Applications to Signal Processing, Prentice Hall, 2002.*
2. **John J. Shynk**, *Probability, Random Variables, and Random Processes: Theory and Signal Processing Applications, Wiley publications.*

MA204	Mathematics-IV	3-0-0-6

Syllabus

Complex Analysis: Complex numbers and elementary properties. Complex functions - limits, continuity and differentiation. Cauchy-Riemann equations. Analytic and harmonic functions. Elementary functions. Anti-derivatives and path (contour) integrals. Cauchy-Goursat Theorem. Cauchy's integral formula, Morera's Theorem. Liouville's Theorem, Fundamental Theorem of Algebra and Maximum Modulus Principle. Taylor series. Power series. Singularities and Laurent series. Cauchy's Residue Theorem and applications. Mobius transformations.

Partial Differential Equations: First order partial differential equations; solutions of linear and nonlinear first order PDEs; classification of second-order PDEs; method of characteristics; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates); initial boundary value problems in non-rectangular coordinates.

Solving PDEs by Transforms Methods: Solution of PDE by Fourier Transform method and Laplace Transform method.

Texts:

1. **J. W. Brown and R. V. Churchill**, Complex Variables and Applications, 7th Edition, Mc-Graw Hill, 2003. (or 8th Edition-2008).
2. **K. Sankara Rao**, Introduction to Partial Differential Equations, 3rd Edition, 2011.

References:

1. **J. H. Mathews and R. W. Howell**, Complex Analysis for Mathematics and Engineering, 3rd Edition, Narosa, 1998.
2. **I. N. Sneddon**, Elements of Partial Differential Equations, McGraw Hill, 1957.

MA205	**Discrete Mathematics**	**3-0-0-6**

Syllabus

Set theory: sets, relations, functions, countability;

Logic - formulae, interpretations, methods of proof, soundness and completeness in propositional and predicate logic;

Number theory: division algorithm, Euclid's algorithm, fundamental theorem of arithmetic, Chinese remainder theorem, special numbers like Catalan, Fibonacci, harmonic and Stirling;

Combinatorics: permutations, combinations, partitions, recurrences, generating functions;

Graph Theory:- paths, connectivity, subgraphs, isomorphism, trees, complete graphs, bipartite graphs, matchings, colourability, planarity, digraphs;

Algebraic Structures: semigroups, groups, subgroups, homomorphisms, rings, integral domains, fields, lattices and Boolean algebras.

Texts:

1. **C. L. Liu**, *Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.*
2. **K. H. Rosen**, *Discrete Mathematics and its Applications, 7th Ed., Tata McGraw-Hill, 2009*.

References:

1. **J. P. Tremblay and R. P. Manohar**, *Discrete Mathematical structures with Applications to Computer Scienec, Tata McGraw-Hill, 2001.*
2. **R. C. Penner**, *Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.*
3. **R. L. Graham, D. E. Knuth, and O. Patashnik**, *Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.*
4. **J. L. Hein**, *Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010*.