

MD 103: Foundation of Mathematics**(L2 -T1 -P0 -CH3 -CR 3)****Unit 1**

Statements, quantifiers, negation, compound statements (conjunction, disjunction, conditional and bi-conditional), contra-positive statement, proofs in Mathematics.

Unit 2

Set, subset, superset, operations viz. union, intersection, complement etc. of sets; power set, cartesian product.

Unit 3

Equivalence relations, equivalence classes, partition, fundamental theorem of equivalence relation.

Unit 4

Functions, injection, surjection and bijection; image and pre-image of set under function, composition of functions, invertible function.

Unit 5

Partial order relation, poset, chain, upper & lower bounds in poset, greatest & least elements, maximal & minimal elements, supremum & infimum, Zorn's lemma, introduction to lattice theory.

Unit 6

Peano's axioms, principle of mathematical induction, well ordering principle, axiom of choice.

Unit 7

Finite and infinite sets, countable and uncountable sets, Schroeder Bernstein Theorem, Continuum hypothesis.

Unit 8

Ordinal numbers, sum and product of ordinal numbers, structure of ordinal numbers.

Text Book(s):

1. Halmos, P. R. *Naive Set Theory* Springer, 2009.
2. Kumar, A., Kumaresan, S. and Sarma, B. K. *A foundation course in Mathematics*, Narosa, 2018.

Reference Book(s):

1. Hrbacek, K. and Jech, T. *Introduction to Set Theory*, 3rd edition, CRC press, 1999.
2. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons, 2005 (reprint, Wiley India, 2011).

MD 105: Real Analysis-I

(L2-T1-P0-CH3-CR3)

Unit-1

Real Numbers: algebraic and ordered properties, completeness property, supremum and infimum and applications. Absolute value and triangle inequality. **Unit-2**

Archimedean property and its applications, density theorem. Intervals, nested interval property. Binary and decimal representation, Cantor's proof of uncountability of $[0,1]$. Cantor set.

Unit-3

Sequences, bounded sequences, tails of a sequence, Cauchy sequence, convergent sequence and its limit, algebra of limits. Monotone sequences, monotone convergence theorem.

Subsequences, divergence criterion. Construction of \mathbb{R} . **Unit-4**

Infinite series, sequence of partial sums. Convergent and absolutely convergent series. Test of convergence. Alternating series. Rearrangement of infinite series.

Text Books:

1. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons, 2005 (reprint, Wiley India, 2011).
2. Kumar, A. and Kumaresan, S. *A Basic Course in Real Analysis*, CRC Press, 2014.

MD 106: Group Theory

(L2 -T1 -P0 -CH3 -CR 3)

Unit-1

Binary operation, semigroup, monoid, group, elementary properties of groups, subgroup, order of an element, coset, Lagrange's theorem and its applications.

Unit-2

Conjugacy class, class equation, normal subgroups and quotient groups. **Unit-3**

Subgroup generated by a set, cyclic subgroups, properties of cyclic groups, fundamental theorem of cyclic group.

Unit-4

Permutation, cycle notation, even and odd permutation, order of a permutation, symmetric group and alternating group. Dihedral group and presentation of group. **Unit-5**

Homomorphism and isomorphism of groups, isomorphism theorems, Cayley's theorem.

Unit-6

Direct product of groups, properties of direct products.

Textbook(s)

1. Gallian, J. A., *Contemporary Abstract Algebra*, 4th edition (Narosa Publishing house, New Delhi, 2009).
2. Dummit, D. S. and Foote, R. M., *Abstract Algebra*, 3rd edition (John Wiley & Sons, Indian reprint, New Delhi, 2011).

Reference book(s)

1. Fraleigh, J. B. *A First Course in Abstract Algebra*, 7th edition (Pearson Education India, New Delhi, 2008).
2. Herstein, I. N., *Topics in Algebra*, 2nd edition (John Wiley & Sons, Indian reprint, New Delhi, 2006).

MD 221: Introductory Statistics & Probability (L2-T1 -P0 -CH3 -CR 3)

Unit-1

Definitions of Statistics, population, sample, data and characteristics of data. Measures of central tendency, dispersion. Histogram, frequency curve and boxplot.

Unit-2

Skewness and its measures. Normal and student's-t curves. Kurtosis and its measures. Effects of change of origin and scale. Definition of Probability and some properties of the probability function.

Unit-3

Random variable, Probability distribution and distribution function. Discrete and continuous distribution. Some important discrete and continuous distributions.

Unit-4

Random sampling and sampling fluctuation, Simple random sampling, variance of sample mean under SRS WOR, Estimation of population size (capture-release- capture method), Correlation and simple linear regression. Rank correlation.

Textbook(s)

1. Medhi, J. *Statistical Methods: An introductory Text*, (New Age International (P) Ltd, 2000).
2. Gupta, S.C. and Kapoor, V. K. *Fundamentals of Mathematical Statistics*, (S. Chand & Co., 2007).
3. Cochran, W.G., *Sampling Techniques*, third edition (John Wiley & Sons, 1977).

Reference book(s)

1. Feller, W. *An Introduction to Probability Theory and Its Applications*, Vol. I, (Wiley, 2005).
2. Uspensky, J.V. *Introduction to Mathematical Probability*, (McGraw Hill, 2005).

MD 223: Calculus I

(L3 -T1 -P0 –CH4 -CR 4)

Unit-1

Indeterminate forms, L'Hospital's Rule, Successive differentiation.

Unit-2

Convexity and point of inflexion; Tangent and Normal; Curvature of plane curves; Asymptotes; Envelopes; Singular points.

Unit 3

Curve tracing: tracing of catenary, cissoids, asteroid, cycloid, folium of Descartes, cardioid, lemniscate. **Unit-4**

Functions of two variables: Limit, Continuity, Partial derivatives, Directional derivatives, Euler's theorem on homogeneous functions, Total Derivative and total differentials, Chain rule, Directional derivatives, Gradient vectors and equations of Tangent planes. **Unit-5**

Partial derivatives of higher order, Taylor's theorem, Criteria for Maxima/ Minima/ Saddle points, Lagrange's method of multipliers.

Unit-6

The relation between integration and differentiation: the derivative of an indefinite integral, the first fundamental theorem of calculus, primitive functions and the second fundamental theorem of calculus, the Leibniz notation for primitives, integration by substitution, integration by parts

Textbook(s)

1. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.
2. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*, (John Wiley and Sons, Third (Indian) Edition), 2007.

Reference book(s)

1. Apostol, T. M. *Calculus*, Vol I & II, (John Wiley and Sons, Second (Indian) Edition), 2007.
2. G. A. Osborne, *Differential and Integral Calculus with examples and applications*, Forgotten Books' Classic Reprint Series, 2011.
3. B. C. Das and B. N. Mukherjee, *Differential Calculus*, U N Dhur & Sons Private Ltd, (19th Editions) 1957
4. R. Courant, *Differential and Integral Calculus*, John Wiley & Sons, 1970.

MD 218 : Introductory ODE & PDE

(L3 -T1 -P0 –CH4 -CR 4)

Unit -1

First order linear and nonlinear ODE: Exact differential equations and integrating factors, separable equations and equations reducible to this form, Bernoulli equation, integrating factors and transformations, Clairaut form, singular solution. Orthogonal and oblique trajectories, rate problems.

Unit -2

Explicit methods of solving higher order linear differential equations: Basic theory of linear differential equations, homogeneous linear differential equations with constant coefficients, method of undetermined coefficients, variation of parameters, Cauchy_euler equation, Wronskian. Statements and proofs of theorems on second order homogeneous linear equations. **Unit -3**

Laplace Transforms: Laplace Transforms of some elementary functions, Linearity property, First and second translational or shifting theorem. Change of scale property, Laplace transforms of derivatives, multiplication by powers of t, and related problems. Laplace transform of periodic functions. Inverse Laplace transforms, Convolution theorem. Solution of ordinary differential equations by Laplace transform.

Unit -4

Series Solutions for ODE, Types of singularity, Solution at an Ordinary Point, Solution at a Singular Point. Method of Frobenius. General solution of Bessel and Legendre equation.

Unit -5

Introduction, Origins of First order PDE, Cauchy Problem for First order equations, Linear equations of first order, Lagrange equation, Integral Surface passing through a given curve, surface orthogonal to a given system of surfaces. **Unit -6**

Nonlinear PDE of first order, Compatible systems of first order equation, Charpit's Method, special types of first order equations, solution satisfying given conditions

Text Book(s):

1. Ross, S.L., Differential equations 3rd edition, (Wiley, 2016).
2. Sneddon, I. Elements of Partial Differential Equations, (Dover, 2006).

MD 222: Co-ordinate Geometry

(L3-T1 -P0 –CH4 -CR 4)

Unit-1

Transformation of co-ordinate axes. Pair of straight lines. General equation of second degree and the conditions for representing a pair of straight lines, a parabola, an ellipse, a hyperbola and a circle. **Unit-2**

Reduction to standard forms: The centre of a conic, Reduction of the equation of a central conic, Equation of the axes and length of the axes, Reduction of the equation of a non-central conic.

The equation of tangent, Condition of tangency of line, Equation of normal, Pair of tangents and director circle, Chord of contact, Pole and polar, Chord in terms of middle points, Diameter and conjugate diameters, Asymptotes.

Unit-3

Polar equation of a conic, tangent and normal, properties. Circle and its parametric form, Orthogonal circle, condition of orthogonality of circles.

Unit-4

Change of axes: shift of origin, rotation of axes. Sphere, Cone and Cylinder.

Unit-5

Central Conicoids: Ellipsoid, Hyperboloid of one and two sheets. Intersection of a conicoid and a line: Tangent line, tangent plane, condition of tangency, Director sphere. Normal: Equation of the normal, number of normals from a given point, cubic curve through the feet of the normal, cone through six normal. Polar plane and polar lines, Enveloping cone, Enveloping cylinder, Diameters and diametral planes, conjugate diameters and diametral planes.

Unit-6

The paraboloid. Reduction of second degree equations.

Text book(s)

1. Jain, P.K. and Ahmad, K. *Text Book of Analytical Geometry of two & three Dimensions*, New Age Publications, 2014.
2. Das, B., *Analytical Geometry and Vector Analysis*, (Orient Book Company, 1995).

Reference book(s)

1. Khan, R.M., *Analytical Geometry & Vector Analysis*, (New Central Book Agency Pvt. Ltd., 2004).
2. Askwith, E. H., *A Course of Pure Geometry*, Michigan Historical Reprint Series (University of Michigan Library, 2005).
3. Askwith, E. H. and Askwith, E., *A Course of Pure Geometry* (Hard Press, 2007).
4. Spain, B. *Analytical Conics* (Dover, 2007).
5. McCrea, W. H. *Analytical Geometry of Three Dimensions* (Dover, 2006).

MD 311: Calculus II**(L3 -T1 -P0 –CH4 -CR 4) Unit-****1**

Reduction formulae for integration. Improper Integral, Beta and Gamma functions.

Unit -2

Line integral, Double integral, triple integral, Jacobian, Surface integral and their applications. Volume, Area, length, volume and surface area of solids of revolution.

Unit-3

Vector Calculus, vector point function, continuity and differentiation of vector point function, partial derivative of vectors, Curl, Gradient, Divergence. Vector Integration.

Unit-4

Green, Gauss and Stokes Theorems and their applications.

Textbook(s)

1. Apostol, T. M. *Calculus*, Vol I & II, (John Wiley and Sons, Second (Indian) Edition), 2007.

References: 1. Spiegel, M. R. *Vector Analysis*, Schaum's outline series, (Publishing House India), 2009.

2. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.
3. B. C. Das and B. N. Mukherjee, *Integral Calculus*, U N Dhur & Sons Private Ltd, (19th Editions) 1977.
4. R. Courant, *Differential and Integral Calculus*, John Wiley & Sons, 1970.
5. G. A. Osborne, *Differential and Integral Calculus with examples and applications*, Forgotten Books' Classic Reprint Series, 2011.

MD313: Programming, Algorithm and Mathematical Software

(L2-T0-P2-CH6--CR 4)

Unit-1

Algorithms and flowcharts. Divide and conquer strategy.

Unit-2

Fundamentals of C: Data types in C, variables in C, input output statements, constant declaration, arithmetic operators in C, arithmetic expressions, assignment statements, arithmetic assignment operators, increment and decrement operators, type conversions, operator precedence.

Unit-3

Basic techniques: sum of numbers, swapping contents of variables, computing area, simple interest etc. Decision making: if statement, if...else statement, the break statement, the continue statement, the go-to statement. **Unit-4**

Looping techniques: for loop, while loop, do...while loop.

Unit-5

Basic operations through Matlab, Input through keyboard and its illustration, Flow Control statements. **Unit -6**

Iterative Method for Solving Non-linear Equation, Numerical Integration, Numerical Solution of 1st order IVP.

Unit -7

Numerical Differentiation and BVP.

Unit -8

Introduction to Mathematica, Symbolic Computation.

Textbook(s)

1. Rajaraman, V., Fundamentals of Computers, (PHI, 2002).
2. Venkateshmurthy, M.G., Programming Techniques through C-A Beginner's Companion, (Pearson Education, 2002).
3. Pratap, R. *Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers* (Oxford University Press, USA , 2005)
4. Otto, S.R. & Denier, J. P. *An Introduction to Programming and Numerical Methods in MATLAB* (Springer, 2009).
5. Torrence, Bruce F. & . Torrence, Eve A. *The student's introduction to Mathematica*, 2nd edition (Cambridge University Press, 2009).

Reference book(s)

1. Hunt, B. R., Lipsman, R. L., Osborn, John E. & Rosenberg, J. Differential Equations with Matlab, (Wiley, 2005).
2. Wolfram, S. The Mathematica Book (Wolfram Media, 2008).
3. Gray, T. W. & Glynn, G. The Beginners Guide to Mathematica, Version 4, Addison- (Wesley, 2008).

MD 315: Statics and Dynamics**(L3-T1-P0-CH4-CR4)****Unit-1** Centre of Mass, Radius of gyration, Centre of gravity of a plane area, arc and sector of a curve. Centre of gravity of solids and surface of revolution.**Unit-2** Friction, laws of friction, limiting friction, equilibrium of a particle in rough inclined plane.**Unit-3** Buoyancy, Hydrostatic equilibrium, Archimedes' Principle, Capillary rise, Surface Tension.**Unit-4** Principle of virtual work in two dimensions, Neutral, Stable and Unstable equilibrium.**Unit-5** Velocities and acceleration, Newton's laws of motion, velocity and acceleration in curvilinear coordinates, tangential and normal components of velocity, acceleration, momentum, force etc.**Unit-6** One dimensional motion in resisting medium; motion of particles of variable mass, Rocket motion. Two dimensional motion, motion of a projectile.**Unit-7** Central force reduced mass, angular momentum; motion under central force, inverse square law of motion, polar equation of orbit, Kepler's laws of motion.**Unit-8** Periodic motion; Simple harmonic motion, Differential equation of simple harmonic motion and solution, Kinetic and Potential energies of Simple harmonic motion, Compound pendulum.**Unit-9** Kinematics of rigid bodies, Euler's theorem, moments and products of inertia. Parallel axes theorem, theorem of six constants. Principal axes.**Textbook(s)**

1. Whittaker, E.T. and McCrea, W. A Treatise on the Analytical Dynamics of Particles and Rigid Bodies: with an Introduction to the Problem of Three Bodies (Cambridge University Press, 1988).
2. Loney, S. L., Elements of Statics & Dynamics, Part I (Maxford Books, 2003).
3. Rao, S. Engineering Mechanics - Statics and Dynamics (Pearson Education, 2008).

Reference book(s)

1. Spiegel, M. R., Schaum's Outline of Theory and Problems of Theoretical Mechanics: with an Introduction to Lagrange's Equations and Hamiltonian Theory (McGraw-Hill, 2007).
2. Ramsey, A. T., Dynamics, 2nd Edition (The University Press, 2007).
3. Chorlton, F. Textbook of Dynamics, 2nd edition (Horwood, 1983).
4. Loney, S. L., An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, (AITBS Publishers, 2016).

MD 316: Introduction to Optimization

(L3 -T1 -P0 –CH4 -CR 4)

Unit-1

General linear programming problems, Standard form of L.P.P., Graphical method for L.P.P.

Unit-2

Geometry of linear programming: Polyhedra and Convex sets, Extreme point, vertices and basic solutions, basic feasible solutions,, Convex function, Convex hull of a set, Convex polyhedrons, Existence of extreme points, optimality of extreme points. **Unit-3**

Supporting hyperplanes and extreme points, Development of Simplex method, Applications of Simplex Technique, Column geometry and the simplex method, Solution of Simultaneous Equations, Inverse of a Matrix By Simplex Method, Problem of Degeneracy. **Unit-4**

The dual Problem, duality theorem, comparison of solutions of primal and its dual. Standard form problems and the dual simplex method along with its limitations, Farkas' lemma and linear inequalities, Separating hyperplane and duality General linear programming duality.

Unit-5

Formulation of LP problem in revised simplex form. Computational procedure (algorithms). Advantage of revised simplex over simplex.

Text Book(s):

1. Hadley, G., Linear Programming, (Narosa Publishing House, New Delhi, 1987).
2. Kanti Swaroop, P.K. Jain and Man Mohan, Operation Research: An Introduction, (S. Chand & Company, New Delhi, 1996).

Reference Books:

1. Taha, H.A. Operation Research: An Introduction, (Macmillan, New York., 1992)
2. Kambo, N.S., Mathematical Programming Techniques, (Affiliated East West Press, New Delhi., 1990).

MD 317: Elementary Complex Analysis

(L3 -T1 -P0 –CH4 -CR 4)

Unit-1

Complex numbers as ordered pairs, Geometric representation of complex numbers, Riemann sphere and Stereographic Projection.

Unit-2

Continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations, harmonic functions.

Unit-3

Elementary analytic functions (exponential function, trigonometric functions and logarithm function) and their mapping properties.

Unit-4

Complex integration, Cauchy-Goursat theorem, Cauchy's integral formula. **Unit-5**
Cauchy's Integral formula for derivatives, Cauchy's inequality and Liouville's theorem, the fundamental theorem of algebra, Maximum-modulus theorem, Morera's theorem.

Textbook(s)

1. Churchill R. V. and Brown, J. W. *Complex variables and applications*, McGraw-Hill International edition, 2006.
2. Mathews, J. H. and Howell, R. W., *Complex Analysis for Mathematics and Engineering*, 3rd Edition, Narosa, 1998.
3. Ponnusamy, *Foundations of Complex Analysis*. 2nd Edition , Narosa Book Distributors Pvt Ltd , 2008.

Reference Book(s)

1. Saff, E. B. and Snider, A. D., *Fundamentals of Complex Analysis with applications to Engineering and Science*, 3rd Edition, Pearson, 2003 (ISBN 978-81-317-2019-6)

MD 318: Introductory Topology

(L3-T1 -P0 –CH4 -CR 4)

Unit-1

Definition and examples of metric spaces, Neighborhoods, Limit points, Interior and boundary points, Open and closed sets, Closure and interior of a set, Equivalent metrics.

Unit-2 Subspaces, Cauchy sequences, Completeness, Cantor's intersection theorem, Baire's category theorem.

Unit-3

Continuous functions, Uniform continuity, Isometry.

Unit-4

Topological spaces, examples, basis and sub-basis, subspaces, closure, interior, exterior and boundary. **Unit-5**

Continuity, open functions, homeomorphisms, embeddings, strong and weak topologies.

Textbooks:

1. O'Searcoid, M., *Metric Spaces*, Springer, 2006.
2. Shirali, S. and Vasudeva, H. L., *Metric Spaces*, Springer, 2007.
3. Munkres, J. R. *Topology : A first course (2/e)*, Pearson Education, 2000

Reference Books:

1. Kumersan, S., *Topology of Metric Spaces*, Narosa, 2011.
2. Simmons, G. F., *Topology and Modern Analysis*, McGraw Hill Education, 2017.

MD 414: Computer Programming+

(L3 -T1 -P0 -CH4 -CR 4)

Unit-1

Revision of fundamentals of C: Data types in C, variables in C, input output statements, constant declaration, arithmetic operators in C, arithmetic expressions, assignment statements, arithmetic assignment operators, increment and decrement operators, type conversions, operator precedence. for loop, while loop, do...while loop, if statement, if...else statement, switch statement, conditional operators. The break statement, the continue statement, the go-to statement.

Unit-2

Arrays: Arrays, declaration of one dimensional arrays, two dimensional arrays.

Structures and Unions: User defined data types, structures, array of structures, unions, enumerated data type.

Unit-3

Searching and Sorting: Bubble sort, selection sort, insertion sort, linear search and binary search. **Unit-4**

Function in C: Simple functions, passing arguments to functions with return value, call by value, call by reference, overloaded functions, inline functions, default arguments.

Unit-5

Pointers: Introduction; accessing address of a variable; pointer declaration, initialization, accessing variable through pointer, chain of pointers; pointer expressions, increment and scale factor. Pointers and Arrays. Array of pointers. Pointers as function arguments.

Unit-6

Files in C: Defining and opening a file, closing a file. Input/Output operations on files.

Unit-7

Dynamic Memory Allocation and Linked list: Dynamic memory allocation, Malloc, Calloc, Free, Realloc. Concepts of linked list, advantages of linked list, types of linked list. Creating a linked list.

Textbook(s)

1. Rajaraman, V. *Fundamentals of Computers* (Prentice Hall of India, New Delhi, 2002).
2. Balaguruswamy, E. *Programming in ANSI C* (Tata McGraw-Hill, 2004).

Reference book(s)

1. Kanetkar, Y. P. *Let us C* (BPB Publication, 2001).
2. Venkateshmurthy, M. G. *Programming Techniques through C* (Pearson Education, 2002).

MD 421 Computer Laboratory

(L0-T0-P2 -CH4 -CR 2)

Practical unit for the course MI 414 Computer Programming