

Department of Mathematical Sciences

Course Structure and Syllabus of Integrated B.Sc.B.Ed. Major in Mathematics (for 2018 entry batch onwards)

Minimum credit requirement	: 180
Minimum duration	: 4 years (8 semesters)
Maximum duration	: 6 years (12 semesters)

COURSE STRUCTURE

Semester I

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 101	Physics-I	2-1-0	3	3	GE
CD 101	Chemistry-I	3-0-0	3	3	GE
CD 107	Chemistry-Lab	0-0-3	6	3	GE
ED 105	Basics in Computer Applications	2-0-1	4	3	CORE
ED 106	Education: An Evolutionary Perspective	2-0-1	4	3	CORE
*MD 101	Mathematics -I	2-1-0	3	3	GE
MD 103	Foundation of Mathematics	2-1-0	3	3	CORE
MD 105	Real Analysis-I	2-1-0	3	3	CORE
ED 104	Communicative English	3-0-0	3	3	AEC
Total credits				24	

* MD 101(Mathematics –I) is only for students not having Mathematics Major

Semester II

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 102	Physics-II	2-1-0	3	3	GE
PD 197	Physics-Lab	0-0-3	6	3	GE
CD 102	Chemistry-II	3-0-0	3	3	GE
ED 107	Education and Development	2-0-1	3	3	CORE
*MD 102	Mathematics -II	2-1-0	3	3	GE
MD 104	Real Analysis-II	2-1-0	3	3	CORE
MD 106	Group Theory	2-1-0	3	3	CORE
NS 102	National Service Scheme	0-0-2	4	2	SEC
ES 103	Environmental Studies	4-0-0	4	4	AEC
Total credits				24	

* MD 102(Mathematics –II) is only for students not having Mathematics Major

Semester III

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 221	Introductory Statistics & Probability	2-1-0	3	3	CORE
MD 223	Calculus-I	3-1-0	4	4	CORE
*MD 219	Mathematics III	2-1-0	3	3	GE
PD 211	Physics-III	2-1-0	3	3	GE
CD 201	Chemistry-III	3-0-0	3	3	GE
ED 201	Environmental Education	2-0-1	4	3	CORE
ED 202	Learner and Learning	2-0-1	4	3	CORE
DM 101	Disaster Management	3-0-0	3	3	SEC
Total credits				22	

*MD 219(Mathematics–III) is only for students not having Mathematics Major

Semester IV

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 218	Introductory ODE & PDE	3-1-0	4	4	CORE
MD 220	Linear Algebra-I	3-1-0	4	4	CORE
MD 222	Co-ordinate Geometry	3-1-0	4	4	CORE
MD 224	Numerical Methods and Boolean Algebra	3-1-0	4	4	CORE
ED 203	Contemporary Issues in Education	2-0-1	4	3	CORE
ED 204	Assessment and Evaluation	2-0-1	4	3	CORE
Total credits				22	

Semester V

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 311	Calculus-II	3-1-0	4	4	CORE
MD 313	Programming Algorithm and Mathematical Software	2-0-2	6	4	CORE
MD 315	Statics and Dynamics	3-1-0	4	4	CORE
MD 317	Elementary Complex Analysis	3-1-0	4	4	CORE
ED 301	Teaching Approaches and Strategies	2-0-1	4	3	CORE
ED 302	Classroom Organization and Management	2-0-1	4	3	CORE
Total credits				22	

Semester VI

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 318	Introductory Topology	3-1-0	4	4	CORE
MD 314	Elementary Number Theory	3-1-0	4	4	CORE
MD 316	Introduction to Optimization	3-1-0	4	4	CORE
MD 322	Seminar	0-0-3	3	3	CORE
ED 308	Pedagogy A: Physical Science-I	2-0-1	4	3	CORE
ED 307/ ED 309	Pedagogy B: Mathematics I/ Pedagogy B: Biological Science I	2-0-1	4	3	CORE
ED 303	School Education in North East India	2-0-0	2	2	CORE
Total credits				23	

Semester VII

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 425	Combinatorics	3-1-0	4	4	CORE
MD 414	Computer Programming+	3-1-0	4	4	CORE
MD 421	Computer Lab	0-0-2	4	2	CORE
ED 408	Pedagogy A: Physical Science-II	2-0-1	4	3	CORE
ED 407/409	Pedagogy B: Mathematics II/ Pedagogy B: Biological Science II	2-0-1	4	3	CORE
ED 404	Initial School Experience/ School Internship-I	0-0-4	8	4	CORE
	Open Elective I [#]	2-1-0	3	3	Open Elective
Total credits				23	

+ Course for which there is a separate practical unit assigned as Computer Laboratory

List to be notified by CoE from time to time

Semester VIII

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 422	Elementary Coding and Information Theory	3-1-0	4	4	CORE
ED 405	School Internship	0-0-16	32	16	CORE
Total credits				20	

Detailed Syllabus

MD 101: Mathematics I

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

Unit-1

Inequalities involving arithmetic, geometric, and harmonic means, Cauchy-Schwarz inequality.

Unit-2

Sequences: Cauchy sequence, Cauchy's General principle of convergence, Subsequences, Convergence and divergence of monotonic sequences, Sandwich theorem.

Infinite series: statements of basic properties of infinite series (without proofs), Convergence, Absolute and conditional convergences. Tests for convergence: Comparison test, Ratio test, Raabe's test, Leibnitz's test.

Unit-3

Functions of one variable: Limit, Continuity, Differentiability, Rolle's Theorem, Mean value theorems and applications, Taylor's theorem.

Unit-4

Critical points, convexity, curvature of plane curves, Asymptotes.

Curve tracing: tracing of catenary, cissoids, asteroid, cycloid, folium of Descartes, cardioid, lemniscate.

Unit-5

Functions of two or more variables: Limit, Continuity, Partial derivatives, Euler's theorem on homogeneous functions, Differentiability, Chain rule, Directional derivatives, Gradient vectors and Tangent planes, Taylor's theorem (statement only), Criteria for Maxima/Minima/Saddle points, Lagrange's method of multipliers.

Textbook(s)

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

Reference book(s)

1. Apostol, T. M. *Calculus*, Vol I & II, (John Wiley and Sons, Second (Indian) Edition).
2. Mapa, S.K. *Higher Algebra*, (Asoke Prakashan, Kolkata).

MD 102: Mathematics II

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

Unit-1

Ordinary differential equations(ODE): Basic definitions: order and degree of differential equation, primitives, solutions of differential equations, Integral curves, isoclines, formulation of ODE, Linear and non-linear differential equations.

Unit-2

Variables separable equation, homogeneous and non-homogeneous equation, exact equations and integrating factors, linear and Bernoulli's equation, equations reducible to first order Clairaut's equation.

Unit-3

Second order Differential Equations: Linear equations with constant coefficients. Standard methods for solution of homogeneous and non-homogeneous linear differential equations, linear differential equations with variable coefficients and Method of Variation of Parameter.

Unit-4

Line integral, Double integral, triple integral, Jacobian, Surface integral and their applications. Space co-ordinates, lines and planes, Polar coordinates, Cylinders, Quadric surfaces, Volume, Area, length, volume and surface area of solids of revolution.

Unit-5

Vector Calculus, vector point function, continuity and differentiation of vector point function, partial derivative of vectors, Curl, Grade, Divergence; Green, Gauss and Stokes Theorem.

Textbook(s)

1. Boyce, William E. and Dprima, Richard, C. *Elementary Differential Equations*, (John Wiley, Indian Edition, 2000).
2. Spiegel, M. R. *Vector Analysis, Schaum's outline series*, (Publishing House India).
3. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition).

Reference book(s)

1. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics*, Third Edition, (Narosa publishing house, India).
2. Ramana, B. V. *Higher Engineering Mathematics*, (McGraw Hill, India).

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 104: Real Analysis-II

(L2-T1-P0-CH3-CR3)

Unit-1

Limits of functions, sequential criterion of limits, squeeze theorem, one sided limits, infinite limits and limits at infinity, continuity of a function, sequential criterion, algebra and composition of continuous functions.

Unit-2

Continuous functions on intervals, maximum-minimum theorem, location of roots and Bolzano's intermediate value theorem. Uniformly continuity. Lipschitz function. Continuous extension theorem.

Unit-3

Differentiability, Rolle's Theorem, Mean value theorems and applications, Taylor's theorem, Expansion of functions by Maclaurin's theorem.

Unit-4

Weierstrass approximation theorem. Bernstein Approximation theorem. Monotone and inverse functions, continuous inverse theorem.

Unit-5

Riemann Integration: definition and properties up to fundamental theorem of integral calculus.

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 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 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 219: Mathematics III

(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 220 : Linear Algebra-I

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

Unit-1

Matrices and System of linear equations, Reduced Row-Echelon form and its relevance to Linear systems, Elementary operation, Gaussian reduction

Unit-2

Vector spaces and Subspaces, Direct sum of subspaces, Quotient space.

Unit-3

Linear combination and Span, Linear Independence, Exchange lemma, Basis of a vector space and Dimension Theory.

Unit-4

Linear transformation, Linear transformations and Linearly Independent Sets, Matrix representation of linear transformations, Transition matrix and similar matrices, Rank of a linear Transformation and Rank of a matrix.

Unit-5

Determinants, Multilinear Transformations, Determinant of a Family of Vectors, of a Matrix, and of a Linear Transformation.

Unit-6

Eigenvalues and eigenvectors, Characteristic polynomial, Cayley-Hamilton Theorem, Diagonalizable Matrices and Linear Transformations .

Text Book(s):

1. Stephen H. F., Arnold J. I. and Lawrence E. S., Linear Algebra, 4th edition, Prentice Hall, 2003.
2. Hoffman, K. and Kunze, R., Linear Algebra, Prentice Hall, 1984.

Reference book(s)

1. Halmos, P. R., Finite dimensional vector spaces, Springer Verlag, New York, 1987.
2. Poole, David, Linear Algebra: A modern introduction, 3rd edition, Brooks/Cole Cengage learning, 2011.

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 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 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, asteroïd, 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 224: Numerical Methods and Boolean Algebra

(L3-T1 -P0 –CH4 -CR 4)

Unit -1

Finite Difference operators and their operations on functions of a single variable. Existence and uniqueness of interpolating polynomial, Lagrange interpolation, Newton divided difference, forward and backward interpolation, central difference interpolation and associated error terms. Extrapolation and inverse interpolation. Properties of divided differences.

Unit -2

Roots of algebraic and transcendental equations: Bisection method, Secant method, Regula-Falsi method, Newton-Raphson method, their geometrical interpretation and derivation.

Unit -3

Numerical differentiation, Richardson's extrapolation.

Numerical integration: Newton –Cotes quadrature formula, Trapezoidal rule, Simpson's 1/3rd and 3/8th rule of integration. Use, interpretation and derivation. Composite Trapezoidal and Simpson's rules. Double integration.

Unit -4

Solution of system of linear algebraic equations: Direct methods- Gauss elimination, pivoting and Gauss-Jordan methods. LU-factorization.

Unit-5

Boolean ring and Boolean algebra, principle of duality, fields of sets, elementary relations.

Textbook(s)

1. Atkinson, K.E., An introduction to Numerical Analysis, 2nd edition (John Wiley and Sons. 2004).
2. Burden, R.L., and Faires, J.D., Numerical analysis theory and applications (Cengage Learning, 2005).
3. Jain, R.K., and Iyenger, S.R.K., Advanced Engineering *Mathematics* (CRC Press, 2002).
4. Givant, S., Halmos, P., Introduction to Boolean algebras, (Springer, 2009).

Reference book(s)

1. Jain, M.K., Iyengar, S.R.K. and Jain R.K. *Numerical methods for Scientific and Engineering Computation*, 5th edition (New Age International (P) Ltd., New Delhi, 2006).
2. Sastry, S.S. *Introductory methods of Numerical Analysis* (Prentice Hall of India, New Delhi, 1997).

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 314: Elementary Number Theory**(L3 -T1 -P0 -CH4 -CR 4)****Unit-1**

Divisibility, greatest common divisor, least common multiple, Euclidean Algorithm.

Unit-2

Prime numbers, factorization in prime numbers, fundamental theorem of arithmetic.

Unit-3

Divisor functions, perfect numbers, Mersenne numbers, Fermat numbers.

Unit-4

Greatest integer function (Gauss function), Mobius function, Euler function.

Unit-5

Concept of congruences and its elementary properties, congruences in one unknown, complete residue system, reduced residue system.

Unit-6

Diophantine equations, linear Diophantine equations, Pythagoras equation, sum of two squares.

Unit-7

Quadratic residues and congruences of second degree in one unknown, Legendre symbol, Jacobi symbol, congruences of second degree with prime modulus and with composite modulus.

Unit-8

Primitive roots and indices, order, necessary and sufficient condition for the existence of primitive roots, construction of reduced residue system.

Unit-9

Continued fractions, simple continued fractions, approximation of irrational numbers by continued fractions, solution of Pell's equation.

Textbook(s)

1. Burton, D. M. *Elementary Number Theory*, 6th Edition (Tata McGraw-Hill, New Delhi, 2007).
2. Niven, I. and Zuckerman, H. *An Introduction to the Theory of Numbers*, 5th Edition (Wiley Eastern, New Delhi, 2000).

Reference book(s)

1. Hardy, G.H. and Wright, E. M., *An Introduction to the Theory of Numbers*, 4th edition (Oxford University Press, 1960).
2. Andrews, G.E., *Number Theory* (Hindustan Publishing Corporation, New Delhi, 1992).
3. Telang, S. G., *Number Theory* (Tata McGraw-Hill, New Delhi, 1996).
4. Hsiung, Y. *Elementary Theory of Numbers* (World Scientific, 1992; First Indian Reprint, Allied Publishers Limited, 1995).

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

MD 422: Elementary Coding and Information Theory**(L3-T1-P0-CH4-CR4)****Unit-1**

Coding and Decoding: Coding, Unique Decoding, Block Codes and Instantaneous Codes, Some Important Block Codes, Construction of Instantaneous Codes, Kraft's Inequality, McMillan's Theorem.

Unit-2

Huffman Codes : Information Source, Huffman Codes, Construction of Binary Huffman Codes, Construction of General Huffman Codes.

Unit-3

Data Compression and Entropy: An Example of Data Compression, The Idea of Entropy, The Definition of Entropy. Maximum and Minimum Entropy, Extensions of a Source, Entropy and Average Length, Shannon's Noiseless Coding Theorem.

Unit-4

Reliable Communication Through Unreliable Channels: Binary Symmetric Channels, Information Rate, Hamming Distance, Detection of Errors, Correction of Errors, Channel Capacity, Shannon's Fundamental Theorem.

Unit-5

Error-Correcting Codes: Binary Addition and Multiplication, Codes Described by Equations, Binary Linear Codes, Parity Check Matrix, The Probability of Undetected Errors.

Text Book(s)

1. Jiří Adámek, *Foundations of Coding: Theory and Applications of Error-Correcting Codes with an Introduction to Cryptography and Information Theory*, John Wiley & Sons, INC, 1991.
2. Richard W. Hamming, *Coding and Information Theory (2nd Ed.)*. Prentice-Hall, Inc., Upper Saddle River, NJ, USA, 1986.

Reference Book(s):

1. Steven Roman, *Coding and Information Theory*, Springer-Verlag New York, 1992.
2. Raymond Hill, *A First Course in Coding Theory*, Oxford University Press, 1990.

MD 425: Combinatorics

(L3 -T1 -P0 –CH4 -CR 4)

Unit-1

Basic counting rules, Permutations: Allocation Problem, Circular and Ring Permutations, Generalized Permutations, Combinations: Allocation Problem, Pascal's formula, Generalized combinations, The Multinomial Theorem, Properties of Binomial Coefficients.

Unit-2

Partitioning of a set, The pigeonhole Principle: simple form, strong form, The inclusion-Exclusion principle, Calculating in two ways: Fubini's Principle, Derangements.

Unit-3

Generating Functions: Ordinary generating Functions, Exponential generating Function.

Unit-4

Recurrence Relations: Homogeneous Recurrence Relations, Inhomogeneous Recurrence Relation.

Text Book(s):

2. V. K. Balakrishnan, *Introductory Discrete Mathematics*, Dover Publications, New York, 1996.
3. Richard A. Brualdi, *Introductory Combinatorics*, 5th Edition, Pearson, 2010.

Reference Book(s):

K. H. Rosen, Discrete Mathematics & its Applications, 6th Edition., Tata McGraw-Hill, 2007.

S. Lipschutz, M. Lipson, Theory and Problems of Discrete Mathematics, 3rd Edition, Schaum's Outline Series, McGraw-Hill.