Department of Mathematical Sciences

Course Structure and Syllabus of Integrated B.Sc.-B.Ed. in Mathematics

Minimum credit requirement: 166 credits
Minimum duration: 4 years (8 semesters)
Maximum semesters: 6 years (12 semesters)

COURSE STRUCTURE

Semester I

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 101	Physics-I	2-0-1	4	3	
CD 101	Chemistry-I	2-0-2	6	4	
BD 101	Biology-I	2-0-1	4	3	
MD 101	Mathematics-I	2-1-0	3	3	
ED 101	Education: An Evolutionary Perspective	2-0-1	4	3	Education
ED 104	Communicative English (Language Proficiency)	2-1-0	3	3	Education
ED 105	Basics in Computer Application	2-0-1	4	3	Education
Total credits				22	

Semester II

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 102	Physics-II	2-0-1	4	3	
CD 102	Chemistry-II	2-0-2	6	4	
BD 102	Biology-II	2-0-1	4	3	
MD 102	Mathematics-II	2-1-0	3	3	
ED 102	Education and Development	2-0-1	4	3	Education
ED 106	National Service Scheme	0-0-2	4	2	Education
	CBCT Elective			3	CBCT
Total credits				21	

Semester III

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 211	Numerical Methods and integrals	2-1-0	3	3	Common Paper
MD 213	Set Theory and Mathematical Logic	2-1-0	3	3	
MD 215	Classical Algebra	2-1-0	3	3	
ED 201	Environmental Education	2-0-1	4	3	Education
ED 202	Learner and Learning	2-0-1	4	3	Education
PD 211	Quantum Physics	2-1-0	3	3	
	CBCT Elective			3	CBCT
Total credits				21	

Semester IV

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 210	Elementary Abstract Algebra	2-1-0	3	3	
MD 212	Introductory Statistics	2-1-0	3	3	Common Paper
MD 214	Linear Space and Linear Programming	2-1-0	3	3	
MD 216	Elementary real analysis	2-1-0	3	3	
ED 203	Contemporary Issues in Education	2-0-1	4	3	Education
ED 204	Assessment and Evaluation	2-0-1	4	3	Education
PD 216/ BD 224	Thermodynamics and Optics / Ecology and Environmental Biology	2-1-0/ 2-1-0	3/ 3	3/ 3	
Total credits				21	

Semester V

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 207	Co-ordinate Geometry	2-1-0	3	3	
MD 209	Statics and Dynamics	2-1-0	3	3	
MD 301	Computer Programming^{+}	3-1-0	4	4	
MD 309	Computer Laboratory	0-0-2	4	2	
ED 301	Teaching Approaches and Strategies	2-0-1	4	3	Education
ED 302	Classroom Organization and Management	2-0-1	4	3	Education
	CBCT Elective			3	CBCT
Total credits				21	

Semester VI

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 307	Elementary Number Theory	3-1-0	4	4	
MD 308	Theory of Ordinary Differential Equations	3-1-0	4	4	
MD 312	Elementary Complex Analysis	2-1-0	3	3	
ED 308	Pedagogy A: Physical Science I	2-0-1	4	3	Education
ED 307/ ED 309	Pedagogy B: Mathematics I/ Pedagogy B: Bio Science I	2-0-1/ 2-0-1	4/ 4	3/ 3	Education
ED 303	School Education in North East India	2 0 0	2	2	Education
	CBCT Elective			3	CBCT
Total credits				22	

Semester VII

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 208	Linear Algebra	3-1-0	4	4	
MD 303	Real Analysis	3-1-0	4	4	
ED 408	Pedagogy A:Physical Science II	2-0-1	4	3	Education
ED 407/ ED 409	Pedagogy B: Mathematics II/ Pedagogy B Biological Science II	2-0-1/ 2-0-1	4/ 4	3/ 3	Education
ED 404	Initial School Experience/ School Internship-I	0-0-3	6	3	Education
	CBCT Elective			3	CBCT
Total credits				20	

Semester VIII

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 410	Measure Theory	2-1-0	3	3	
ED 405	School Internship	0-0-12	24	12	Education
	CBCT Elective			3	CBCT
Total credits				18	

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

L: Lectures T: Tutorials P: Practical CH: Contact Hours (all per week) CR: Credit

MD: Courses offer by the Department of Mathematical Sciences

PD: Courses offer by the Department of Physics

CD: Courses offer by the Department of Chemical Sciences

BD: Courses offer by the Department of Molecular Biology and Biotechnology

Total Credit : (22+21+21+21+21+22+20+18) = **166**

Total Credit in Lab & Project : (4+4+0+0+2+0+0+0) = **10**

Education Component : (9+5+6+6+6+8+9+12) = **61**

Total Credit in Lab & Project of Education Component: (2+3+2+2+2+2+5+12) = **30**

Total Credit excluding Lab & Project : = **126**

Total Credit in CBCT (Choice-based credit transfer): (0+3+3+0+3+3+3+3) = **18**

CBCT Electives are to be chosen from the general list of CBCT courses available for that particular semester.

DETAILED SYLLABI

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), 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. Mapa, S.K. *Higher Algebra,* (Asoke Prakashan, Kolkata), 2011.

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. 1. Boyce, William E. and Dprima, Richard, C. *Elementary Differential Equations*, (John Wiley, Indian Edition, 2000).
2. 2. Spiegel, M. R. *Vector Analysis*, *Schaum's outline series, (*Publishing House India),
3. 2009.
4. 3. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.

Reference book(s)

1. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics,* Third Edition, (Narosa publishing house, India), 2009.
2. Ramana, B. V. *Higher Engineering Mathematics*, (McGraw Hill, India), 2010.

MD 211 Numerical Methods and Integrals (L2-T1 -P0 -CH3 -CR 3)

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, Hermite interpolation and associated error terms. Extrapolation and inverse interpolation. Properties of divided differences.

Unit -2

Roots of algebraic and transcendental equations: bisection method, Newton-Raphson method, secant method and their geometrical interpretation.

Unit -3

Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8th rule of integration. Use and interpretation.

Unit -4

Reduction formulae for integration of the following functions:

$$x^n e^{ax}, x^m \sin nx, x^m \cos nx, x^n (\log x)^m, \frac{1}{(x^2+k^2)^n}, \sin^n x, \cos^n x, \sin^p x \cos^p x \quad (p>0, q>0),$$

$$\tan^n x, \cos^m x \cos nx.$$

Properties of definite integrals.

Unit -5

Rectification, Quadrature, volume and surface area of solids of revolution.

Unit -6

Elementary idea of Improper Integrals, their convergence, Beta and Gamma functions, their properties. Improper integrals involving a parameter.

Textbook(s)

1. Jain, M.K., Iyengar, S.R.K. and Jain R.K. *Numerical methods for Scientific and Engineering Computation*, 5^{th} edition (New Age International (P) Ltd., New Delhi, 2006).
2. Jain, R.K.. and Iyenger, S.R.K. , Advanced Engineering *Mathematics* (CRC Press, 2002).

Reference book(s)

1. Trench, W.F. , *Introduction to real Analysis* (Prentice Hall, 2002).
2. Narayan, S., Mittal, P.K., *Integral Calculus* (S. Chand & Co., 2005).
3. Sastry, S.S. *Introductory methods of Numerical Analysis* (Prentice Hall of India, New Delhi, 1997).
4. Ahmad, K., *Text Book of calculus,* Real World Education Publishers, New Delhi, 2014.

MD 212 Introductory Statistics (L2 -T1 -P0 -CH3 -CR 3)

Unit-1

Collection of data, methods of collections of primary data, presentation and classification of data.

Unit-2

Discrete and continuous variables, Frequency distributions, Graphical representation, cumulative frequency distribution and ogives.

Unit-3

Measures of location, the arithmetic mean of group data, properties of arithmetic mean, median and mode; other measures of location: quartiles, deciles and percentiles.

Unit-4

Measures of dispersion, Variance and standard deviation of ungrouped and grouped data, properties of standard deviation, moments, skewness and Kurtosis, coefficient of variation.

Unit-5

Correlation and regression: scatter diagram, coefficients of correlation, properties of correlation coefficient, linear regression, fitting of regression line, the method of least squares, curve fitting, properties of regression coefficient, explained and unexplained variation, correlation and regression for grouped data, 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).

Reference book(s)

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

MD 213 Set Theory and Mathematical Logic (L2 -T1 -P0 -CH3 -CR 3)

Unit 1

Statement, truth values, negation, conjunction, disjunction, conditional and biconditional, contrapositive statement.

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, 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 4

Functions, injection, surjection and bijection; image and pre-image of set under function and inverse mapping, composite mapping.

Unit 5

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

Unit 6

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

Text Book(s):

1. P. R. Halmos, *Naive Set Theory* Springer, 2009.
2. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis,* (John Wiley and Sons, Third (Indian) Edition), 2007.

Reference Book(s):

1. K. Hrbacek and T. Jech, *Introduction to Set Theory* , 3rd edition, CRC press, 1999.

MD 215 Classical Algebra (L2 -T1 -P0 -CH3 -CR 3)

Unit-1
Review of basic inequalities, Weierstrass's, Holder's, Jensen's and Minkoski's inequalities.
Unit-2
De Moivre's theorem and its applications. Exponential and trigonometric functions of complex arguments. Gregory's series. Hyperbolic functions.
Unit-3
Polynomials, Euclid's Algorithm, Fundamental theorem of Algebra (statement only), roots and their multiplicity. Descartes rule of sign, Strum's theorem (statement only). Rational roots of polynomials with integral coefficients.
Unit 4:
Relation between the roots and coefficients of a general polynomial equation in one variable, symmetric functions of roots. Transformation of equations, solution of cubic equation by Cardon's method, solution of biquadratic equation by Ferrari's and Euler's methods.
Unit 5:
Symmetric, skew symmetric, Hermitian and skew Hermitian matrices, elementary operations on matrices, elementary matrices and inverse of a matrix. Determinants and its properties. Rank of a matrix, invariance of rank under elementary operations, normal form. System of linear equations and their solutions.
Textbook(s)
1. Mapa, S. K. *Higher Algebra,* Asoke Prakashan, Calcutta, 2006.
2. Hoffman, K. & Kunze, R. *Linear Algebra*, PHI, 2000.

Reference book(s)
1. Bernard, S. & Child, J.M. *Higher Algebra*, Macmillan India Ltd, 2000.
2. Das, B.C. *Higher Trigonometry,* U.N. Dhur and Sons Pvt. Ltd., Calcutta, 2012.

MD 210 Elementary Abstract Algebra (L2 -T1 -P0 -CH3 -CR 3)
Unit-1
Binary operation, semigroup, monoid, group, subgroup, coset, Lagrange's theorem and its applications, index of a subgroup, normal subgroup and quotient group.
Unit-2
Subgroup generated by a set, cyclic subgroups, order of an element, properties of cyclic group.
Unit-3
Permutation, cycle notation, even and odd permutation, order of a permutation, symmetric group and alternating group.
Unit-4
Homomorphism and isomorphism of groups, isomorphism theorems, Cayley's theorem.
Unit-5

Ring, integral domain, field, characteristic of ring, subring and ideal of ring, quotient ring

Unit-6

Homomorphism and isomorphism of rings, isomorphism theorems, ideal generated by a set, principal ideals, prime ideals, maximal ideals.

Textbook(s)

1. 1. Gallian, J. A., *Contemporary Abstract Algebra*, 4th edition (Narosa Publishing house, New Delhi, 2009).
2. 2. Dummit, D. S. & Foote, R. M., *Abstract Algebra*, 3rd edition (John Wiley & Sons, Indian reprint, New Delhi, 2011).
3. 3. Herstein, I. N., *Topics in Algebra*, 2nd edition (John Wiley & Sons, Indian reprint, New Delhi, 2006).

Reference book(s)

1. Fraleigh, J. B. *A First Course in Abstract Algebra*, 7th edition (Pearson Education India, New Delhi, 2008).
2. Lang, S. *Algebra*, 3rd edition (Springer India, New Delhi, 2006).
3. Gopalakrishnan, N. S. *University Algebra* (New Age International (P) Ltd, New Delhi, 2001).

MD 214 Linear Space and Linear Programming (L2 -T1 -P0 -CH3 -CR 3)

Unit 1

Systems of linear equations, Vector space, Subspace, Direct sum of subspaces, Basis and dimension, Rank of a matrix.

Unit 2

Linear transformation, Linear functional, Matrix representation of a linear transformation, Transition matrix and similar matrices.

Unit 3

Determinant of a linear operator, Eigenvalues and eigenvectors, Characteristic polynomial, Cayley-Hamilton Theorem.

Unit 4

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

Unit 5

Basic solutions, Basic feasible solutions, Convex sets, Extreme point, Convex function, Convex hull of a set, Convex polyhedrons, Convex cone, Polytope.

Unit 6

Supporting hyperplanes and extreme points, Simplex method, Simplex algorithm.

Text Book(s):

1. 1. Halmos, P. R., *Finite dimensional vector spaces,*Springer Verlag, New York, 1987.
2. 2. Hoffman, K. and Kunze, R., *Linear Algebra*, Prentice Hall, 1984.
   2. Hadley, G., *Linear Programming*, (Narosa Publishing House, New Delhi, 1987).

Reference book(s)

1. Swaroop, Kanti; Jain, P.K. and Mohan, Man, *Operation Research*: An Introduction, (S. Chand & Company, New Delhi, 1996).
2. Poole, David, *Linear Algebra: A modern introduction*, 3rd edition, Brroks/Cole Cengage learning, 2011.

MD 216 Elementary Real Analysis (L2 -T1 -P0 –CH3 -CR 3)

Unit-1

Real Numbers, Bounded sets, completeness, Archimedean and density properties of real numbers.

Unit-2

Metric Space, open and closed sets, interior, closure and boundary of sets, Cauchy and convergent sequences, Subsequence, complete metric space, Cantor's Intersection theorem, and continuous functions.

Unit-3

Continuity and differentiability of functions of one variable, their properties, Bolzano's theorem, intermediate value theorem. Rolle's theorem, Mean value theorems (Lagrange's and Cauchy's), Darboux's theorem. Taylor's theorem, expansion of functions by Maclaurin's theorem.

Unit-4

Differentiability of functions of two variables, partial derivatives of higher order, Young's and Schwarz theorems.

Unit-5

Riemann integrals, properties, Mean value theorem, Fundamental theorem of calculus.

Textbook(s)

1. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*, (John Wiley and Sons, Third (Indian) Edition), 2007.
3. Apostol, T. M. *Mathematical Analysis* (Narosa Publishing House, 1985).

Reference book(s)

1. Goldberg, R. R *Methods of real analysis (*Oxford & IBH, 1970).
2. Simmons, G. F. *Introduction to Topology and Modern Analysis* (Tata McGraw Hill Book Co. Ltd., 1963).
3. Carothers, N. L. *Real Analysis*, Cambridge University Press, Indian Edition, 2009.

MD 207 Co-ordinate Geometry (L2 -T1 -P0 -CH3 -CR 3)

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

The equation of tangent, condition of tangency of line, pole and polar, centre of a conic, equation of a pair of tangents. Reduction to standard forms, central conics, Equation of the axes and length of the axes.

Unit-3

Polar equation of a conic, tangent and normal, properties. Parabola, parametric co-ordinates, tangent and normal. Ellipse and its conjugate diameters with properties. Hyperbola and its asymptotes. Circle and its parametric form, Orthogonal circle, condition of orthogonality of circles.

Unit-4

Plane, straight line and shortest distance. Change of axes, shift of origin, rotation of axes, Sphere, Cone and Cylinder.

Unit-5

Central Conicoids, Ellipsoid, Hyperboloid of one and two sheets. Generating lines, Diametral planes, tangent lines, plane section of conicoids, director sphere, polar plane, section with a given centre, enveloping cone and cylinder. Confocal conicoids. 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)

3. 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 209 Statics And Dynamics (L2 -T1 -P0 -CH3 -CR 3)

Unit-1

Parallel forces, Couples, Reduction of coplanar forces. Analytical conditions of equilibrium of coplanar forces.

Unit-2

Centre of gravity of a plane area, arc and sector of a curve. C. G. of solids and surface of revolution.

Unit-3

Friction, laws of friction, limiting friction, equilibrium of a particle in rough inclined plane.

Unit-4

Principle of virtual work in two dimensions. Stable and unstable equilibrium.

Unit-5

Velocities and acceleration along radial and transverse directions, along tangential and normal directions.

Unit-6

Rectilinear motion with variable acceleration. Motion under inverse square law and other laws of force.

Unit-7

Simple harmonic motion. Motion in resisting medium. Motion of particles of varying mass. Motion of a projectile.

Unit-8

Central orbit and Kepler's laws of planetary motion.

Unit-9

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*, (Read Books, 2007).

MD 301 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).

+ *Practical unit for the course MD 301 to be done in the course MD 309 Computer Laboratory I.*

MD 309 Computer Laboratory+ (L0-T0-P2 -CH4 -CR 2)

+ *Practical unit for the course MI 301 Computer Programming.*

MD 307 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 308 Theory of Ordinary Differential Equations (L3 -T1 -P0 -CH4 -CR 4)

Unit -1

Review of fundamentals of ODEs, Some basic mathematical models, direction fields, classification of differential equation, Solutions of some differential equation. 1st order non-linear differential equation.

Existence and Uniqueness problem, Gronwall's inequality, Peanao existence theorem, Picard existence and uniqueness theorem, interval of definition.

Unit -2

Second order linear differential equation, General solution for homogeneous equation, superposition of solutions, Methods of solution for non-homogeneous problem: undetermined coefficients, variation of parameters.

Unit -3

Series Solutions for ODE, Types of singularity, Solution at an Ordinary Point, Solution at a Singular Point.

Unit -4

nth order differential equation, system of equation, homogeneous system of equation, fundamental matrix, Abel-Liouvelle formula, System of non-homogeneous equations, Stability of linear systems.

Unit -5

Theory of two point BVP, Greens function, Greens matrix, properties of greens functions, Adjoint and self adjoint BVP.

Unit -6

Strum-Liouvilles problem, Orthogonal functions, eigen values & eigen functions, Completeness of the Eigen functions.

Unit -7

Orthogonal trajectory of a system of curves on a surface solution of pfaffian differential equations in three variables.

Textbook(s)

1. Boyce, W. E. and DiPrima, R. C. *Elementary Differential Equation and Boundary Value Problems*, 7th Edition (John Wiley & Sons(Asia), 2001).
2. Ross, S. L. *Differential Equations*, 3rd edition (Wiley 1984).

Reference book(s)

1. Simmons, G. F. *Differential Equations with Applications and Historical Notes* (McGraw Hill, 1991).
2. Coddington, E. A. *An Introduction to Ordinary Differential Equations* (Prentice-Hall, 1974).
3. Farlow, S. J. *An Introduction to Differential Equations and Their Applications* (McGraw-Hill International Editions, 1994).

MD 312 Elementary Complex Analysis (L2 -T1 -P0 –CH3 -CR 3) 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 208 Linear Algebra (L3 -T1 -P0 –CH4 -CR 4)

Unit-1

Matrix representation of a linear transformation, Annihilating polynomial of a linear transformation; Elementary Canonical forms: diagonalization and triangulation of linear operators.

Unit-2

Primary Decomposition theorem; rational and Jordan forms.

Unit-3

Inner product spaces: inner product, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization process

Unit-4
Linear functionals and adjoints; self adjoint, normal and unitary operators; orthogonal projections; spectral theorem for normal operators on a finite dimensional vector space.
Unit- 6
Bilinear forms: bilinear, positive and quadratic forms.
Text Book(s) :

1. 1. Halmos, P. R., *Finite dimensional vector spaces,*Springer Verlag, New York, 1987.
2. 2. Hoffman, K. and Kunze, R., *Linear Algebra*, Prentice Hall, 1984.
3.

Reference Book(s) :

4. 1. Halmos, P. R.**,** *Linear Algebra Problem Book***,** The Mathematical Association of America (MAA), USA, 1995.

2. Williams, G.**,** *Linear Algebra with Applications***,** Jones and Burlet Publishers, 2001.

MD 303 Real Analysis (L3 -T1 -P0 -CH4 -CR 4)

Unit-1
Metric space, Completeness, Uniform continuity, compactness and connectedness.
Unit-2
Riemann-Stieltjes integrals, properties, Mean value theorem, Fundamental theorem of calculus.
Unit-3
Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration.
Unit-4
Functions of several variables, Derivative on a open subset of R^n, Jacobians, chain rule, directional derivative, derivative of higher order, Taylor's theorem. Inverse function theorem, Implicit function theorem, extermum problem with constraints, Lagrange's method of multipliers.
Textbook(s)

1. Apostol, T. M. *Mathematical Analysis* (Narosa Publishing House, 1985).
2. Rudin, W. *Principles of Mathematical Analysis* (McGraw Hill, 1982).

Reference book(s)

1. Goldberg, R. R *Methods of real analysis (*Oxford & IBH, 1970).
2. Simmons, G. F. *Introduction to Topology and Modern Analysis* (Tata McGraw Hill Book Co. Ltd., 1963).
3. Carothers, N. L. *Real Analysis,* Cambridge University Press, Indian Edition, 2009.

MD 410 Measure Theory (L2 -T1 -P0 –CH3 -CR 3)
Unit-1
Algebra of sets, Borel sets, Extended real numbers.
Unit-2
Lebesgue measure on the Real Line: Lebesgue outer measure, Properties of outer measure, Measurable sets and Lebesgue measure, Non-measurable sets.
Unit-3
Measurable functions, Borel measurability, Simple functions, Littlewood's principles.
Unit-4
Lebesgue Integral of simple functions, Lebesgue integral of bounded functions, Bounded convergence theorem, Comparison of Riemann and Lebesgue integral.
Unit-5
Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, Lebesgue general integral, Lebesgue dominated convergence theorem.
Unit-6

Lp Space, Minkowski and Holder inequalities, Convergence and completeness, Bounded linear functionals on *Lp* Space.

Textbook(s)

1. Royden, H. L. *Real Analysis*, 3rd Edition (Macmillan Publishing Company, New York, 1988) (Reprint 2003).
(OR)
Royden, H.L. and Fitzpatrick, P. M., Real Analysis, 4th Edition, Pearson, 2010.
2. Barra, G. De. *Measure Theory and Integration* (New Age International(P) Ltd, Publishers, New Delhi 2003).

Reference book(s)

1. Rana, I. K. *An Introduction to Measure and Integration*, 2nd edition, Narosa Publishing House India, 2000.
2. Halmos, P. R. *Measure Theory*, Springer-Verlag, 1974.
3. Jain, P. K. and Gupta, V. P. *Lebesgue Measure and Integration*, New Age International (P) Limited, New Delhi, 1986.
4. Cohen D. L., *Measure Theory*, Birkhauser, 1980.