Department of Mathematical Sciences

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

(Major in Mathematics)

Minimum credit requirement: 114
Minimum duration: 3 years (6 semesters)
Maximum duration: years (semesters)

COURSE STRUCTURE

Semester I

Course Code	Course Name	L-T-P	CH	CR	Remark
EG 110	Communicative English	2-0-0	2	2	
CS 101	Basics in Computer Applications	2-0-1	4	3	
PD 101	Physics-I	2-0-1	4	3	
CI 101	Chemistry-I	2-0-2	6	4	
MD 101	Mathematics-I	2-1-0	3	3	
BD 101	Biology-I	2-0-1	4	3	
Total credits				18	

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	
ES 102	Elementary Environmental Science	2-0-0	2	2	
NS 102	National Service Scheme	0-0-1	1	1	
SC 102	Basic Sociology	2-0-0	2	2	
Total credits				18	

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
SC: Courses offer by the Department of Sociology
NS:
ED:
+ 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

Semester III

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 201	Introductory Statistics	2-1-0	3	3	
MD 203	Linear Spaces and Complex Numbers	2-1-0	3	3	
MD 205	Algebra	2-1-0	3	3	
MD 207	Co-ordinate Geometry	2-1-0	3	3	
MD 209	Statics and Dynamics	2-1-0	3	*3*	
PD 202	Introductory Quantum Mechanics (Common)	2-1-0	3	3	
PD 209	Physics Laboratory-II	0-0-2	4	2	
Total credits				20	

Semester IV

Course Code	Course Name	L-T-P	CH	CR	Remark
MD 202	Probability and Mathematical Statistics	3-1-0	4	4	
MD 204	Mathematical Methods and PDE	2-1-0	3	3	
MD 206	Integral Equations and Transforms	3-1-0	4	4	
MD 208	Linear Algebra	3-1-0	4	4	
BD 202 or PD 212	Ecology and Environmental Biology or Electronics (non physics major)	2-1-0 or 2-1-0	3 or 3	3 or 3	
BD 210 or PD 210	Bioscience Laboratory-IIB or Physics Laboratory-IV	0-0-2 or 0-0-2	4 or 4	2 or 2	
Total credits for major students				20	

Semester V

Course Code	Course Name	L-T-P	CH	CR	Remark
ED101	Education and Development- I (C)	2-0-0	2	2	
MD 301	Computer Programming^{+}	3-1-0	4	4	
MD 303	Real Analysis	3-1-0	4	4	
MD 305	Abstract Algebra	3-1-0	4	4	
MD 307	Elementary Number Theory	3-1-0	4	4	
MD 309	Computer Laboratory	0-0-2	4	1	
Total credits				19	

Semester VI

Course Code	Course Name	L-T-P	CH	CR	Remark
ED 102	Education and Development- II (C)	2-0-0	2	2	
MD 302	Numerical Analysis^{+}	3-1-0	4	4	
MD 304	Topology	3-1-0	4	4	
MD 312	Complex Analysis	3-1-0	4	4	
MD 308	Theory of Ordinary Differential Equations	3-1-0	4	4	
MD 310	Computer Laboratory	0-0-2	4	1	
Total credits				19	

Total Credit Load: (18+18+20+20+19+19) =114

Detailed Syllabi

MD 101 Mathematics I (L2 -T1 -P0 -CH3 -CR 3)

Unit-1
Inequalities involving arithmetic, geometric, and harmonic means, Cauchy-Schwarz inequality, Real numbers.

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, Test 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
Linear Approximation, Newton and Picard method, Approximation by polynomials, Critical points, convexity, curvature of plane curves, Asymptotes.
Curve tracing: tracing of catenary, cissoids, asteroid, cycloid, folium of Descartes, cardiod, 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.

Unit-6
Improper integrals, Numerical Integration: Trapezoidal and Simpson's rule; error bounds.

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 201 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.

Unit-5
Elements of probability theory, classical definition of probability, axiomatic approach to probability, probability of a simple event, probability of composite event, addition rule, multiplication rule: conditional probability.

Unit-6
Probability Distributions: Binomial distribution, Properties of Binomial Distribution, Stirling approximation, Poisson Distribution, Properties of Poisson distribution. Moments of higher order, relation between m_r and $m_{r'}$, skewness and Kurtosis.

Unit-7
Correlation and regression: scatter diagram, coefficients of correlation, linear regression, fitting of regression line, the method of least squares, explained and unexplained variation, coefficient of variation, correlation and regression for grouped data.

Unit-8
Tests of significance, Null hypothesis and hypothesis testing; Chi-square distribution and tests related. Non parametric tests, 't' tests – paired and student 't' tests, 'F' test, critical difference at 0.01 and at 0.05.

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).
2. Uspensky, J.V. *Introduction to Mathematical Probability*, (McGraw Hill, 2005).

MD 202 Probability and Mathematical Statistics (L3 -T1 -P0 -CH4 -CR 4)

Unit-1
Discrete sample space, Bayes' formula, Discrete random variable, expected value of a random variable.

Unit-2
Standard probability distribution: Bernoulli, Binomial, Hypergeometric, Geometric, Poisson and Normal distribution.

Unit-3
Elements of Sampling theory: sampling with and without replacement.

Unit-4
Sampling distribution of the sample mean, sampling distribution of proportion, standard error.

Textbook(s)
1. Medhi, J. *Statistical Methods: An introductory Text* (New Age International (P) Ltd, 2000).

Reference book(s)
1. Feller, W. *An Introduction to Probability Theory and Its Applications*, Vol. I (Wiley, 2005).

MD 203 Linear Spaces and Complex Numbers (L2 -T1 -P0 -CH3 -CR 3)

Unit-1
Algebra of matrices; symmetric, skew symmetric, Hermitian and skew Hermitian matrices; elementary transforms, reduction to echelon and normal form.

Unit-2
System of linear equations, existence and uniqueness of solutions, rank of a matrix.

Unit-3
Definitions and examples of vector spaces, elementary properties of and as vector spaces, subspaces, operations on subspaces.

Unit-4
linear dependence and independence of vectors, basis and dimension of vector spaces.

Unit-5
linear mappings and their algebraic properties; eigenvalues and eigenvectors, characteristic equation, statement of Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Unit-6
Algebraic properties of complex numbers, geometrical interpretation of complex numbers, modulus and argument of complex numbers; exponential and trigonometric functions of a complex variable.

Unit-7
theorems on limit and continuity of a function of complex variable, differentiability, analytic function, Cauchy-Riemann equations, Harmonic functions.

Unit-8
derivatives of elementary functions; contour integration, Cauchy's integral theorem, Cauchy's integral formula.

Textbook(s)
1. Churchill R. V. and Brown, J. W. *Complex variables and applications*, (McGraw-Hill International edition, 2006).
2. Hoffman K. and Kunze, R. *Linear Algebra*, 2nd edition, (Prentice Hall, 2008).

Reference book(s)
1. Dutta K. B. *Matrix and Linear Algebra*, (Prentice Hall of India, 2008).
2. Lang S. *Linear Algebra*, (Springer-Verlag, 2006).
3. Spiegel M. R. *Theory and Problems of Complex Variables*, Schum's Outline Series, (McGraw-Hill, 2000).

MD 204 Mathematical Methods and Partial Differential Equations (L2-T1 -P0 -CH3 -CR 3)

Unit -1
Partial differential equations: What are partial differential equations (PDEs), and where do they come from? Flows, vibrations and diffusions. Solutions of first order PDEs: Charpits method, Jacobi method.

Unit -2
Second-order linear equations and their classification. Initial and boundary conditions, with an informal description of well-posed problems. D'Alembert's solution of the wave equation. Duhamel's principle for one dimensional wave equation. Separation of variables: application of the method to simple problems in Cartesian coordinates for one dimensional wave and heat equations.

Unit -3
Calculus of variation: Variational problems with fixed boundaries-Euler's equation for functionals containing first order derivative and one independent variable. Extremals. Functionals dependent on higher order derivatives. Functionals dependent on more than one independent variable. Variational problems in parametric form. Invariance of Euler's equation under co-ordinate transformation. Variational problems with Moving boundaries-Functionals dependent on one and two functions. One sided vatiations. Sufficient conditions for an extremum - Jacobi and Legendre conditions.

Unit -4
Special Functions: Series solution of differential equations. Power series method. Bessel and Legendre equations. Bessel and Legendre functions and their properties. Convergence. Recurrence and generating functions.

Textbook(s)
1. Rao, K. S. *Introduction to Partial Differential Equations*, 2nd Edition (Prentice Hall of India, 2007).
2. Gupta, A. S. *Calculus of Variation with Applications*, (Prentice Hall of India, 1997).
3. Gelfand, I. M. and Fomin, S. V. *Calculus of Variation*, (Dover Publications, 2000).

Reference book(s)
1. Andrews, G.E., Askey, R. A. and Roy, R. *Special Functions*, (Cambridge University Press, 1999).

2. Sneddon, I. N. *Elements of Partial Differential Equations*, 4th ed., (Dover, 2006).

MD 205 Algebra (L2 -T1 -P0 -CH3 -CR 3)

Unit-1
Relations, Equivalence relations, Mapping and binary operations

Unit-2
Groups, subgroups, cosets, Lagrange's theorem, Subgroup generated by a set, cyclic groups permutation groups, normal subgroups, quotient groups.

Unit-3
Polynomials, Euclid's Algorithm, greatest common divisor, unique factorization of polynomials over a field F of numbers (statement only), Fundamental theorem of Algebra (statement only), roots and their multiplicity, Irreducible polynomials over Q, R, C.

Unit-4
Relationship between roots and the coefficients, Fundamental theorem of symmetric polynomial (without proof), Evaluation of symmetric functions of roots. Rational roots of polynomials with integral coefficients.

Unit-5
Descartes rule of sign, Strum's theorem (statement only) Solution of cubic equation, Cardon's method and solution of bi-quadratic equation.

Textbook(s)
1. Gallian, J. A. *Contemporary Abstract Algebra*, Narosa, 1995.
2. Mapa, S. K. *Higher Algebra*, Asoke Prakashan, Calcutta, 2006.

Reference book(s)
1. Herstein, I. N. *Topics in Algebra*, 2nd Edition (Wiley Eastern Limited, 1998).
2. Fraleigh, J. B. *A First Course in Abstract Algebra*, (Narosa, 1995).
3 Barbeau, E. J. *Polynomials*, (Springer 2003).

MD 206 Integral Equations and Transforms (L3 -T1 -P0 -CH4 -CR 4)

Unit -1
Elementary idea of Improper Integrals, their convergence, Beta and Gamma fnctions, their properties. Integral as a function of parameter (excluding improper integrals). Continuity and derivability of an integral as a function of a parameter.

Unit -2
Linear integral equations of the first and second kind of Fredholm and Volterra type: Definitions of integral equations and their classification. Eigen values and Eigen functions. Integral equations of second kind with separable kernels. Reduction to a system of algebraic equations. Method of successive approximations. Iterative scheme for integral equations of the second kind.

Unit -3
Integral Transform Methods: Fourier Series, Generalized Fourier series, Fourier Cosine series, Fourier Sine series, Fourier integrals. Fourier transform, Laplace transform. Inverse Transform: Inverse Laplace and Fourier Transform, Solution of differential equation by Laplace and Fourier transform methods.

Unit -4
Tensor: Transformation of coordinates, summation convention, kronecker delta. Definition of tensors, covariant, contravarient and mixed tensor, symmetric and antisymmetric tensors, outer and inner product of tensors, contraction, quotient law.

Textbook(s)
1. Parashar, B.P. *Differential and Integral Equations*, 2nd ed., (CBS Publishers, 2008).
2. Mikhlin, S. G. *Linear Integral Equations*, (Hindustan Book Agency, 1990).
3. Spain, B. *Tensor Calculus*, (Radha Publishing House, 2000).

Reference book(s)
1. Kanwal, R. P. Linear Integral Equation. Theory and Techniques, (Academic Press, 1991).
1. Poularikas, D. *The Transforms and Applications*, (CRC Press, 1996).

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.

Textbook(s)
1. Jain,P. K. and Ahmed, K., *Textbook of Analytical Geometry of Two Dimensions* (New Age Publications, 2006).
2. Jain, P. K. and Ahmed, K., *Textbook of Analytical Geometry of Three Dimensions*, 2nd Edition (New Age Publication, 2006).

3. 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 208 Linear Algebra (L3 -T1 -P0 -CH4 -CR 4)

Unit-1
Vector Space: Vector Spaces; bases and dimension; direct sum; dual space; quotient space (Revision).

Unit-2
Linear transformations: The algebra of linear transforms; representation of linear transforms by matrices; linear functionals; the double dual.

Unit-3
Eigen values and eigen vectors; annihilating polynomials; triangulation and diagonalization.

Unit-4
Primary Decomposition theorem; rational and Jordan forms.

Unit-5
Inner product spaces: inner product; Gram-Schmidt orthogonalization process.

Unit-6
Linear functionals and adjoints; self adjoint, normal and unitary operators; orthogonal projections; spectral theorem for normal operators on a finite dimensional vector space.

Unit- 7 Bilinear forms: bilinear, positive and quadratic forms.

Textbook(s)

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

Reference book(s)

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 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 books

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
Computer fundamentals: major hardware and software components of a digital computer, concepts of machine language, assembly language and high level language.

Unit-2
Number systems: binary, octal, hexadecimal; algebraic operations and conversions. Algorithms and flow charts.

Unit-3
Fundamentals of C: introduction to C; comments in 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-4
Loops and decisions: for loop, while loop, do…while loop, if statement, if…else statement, switch statement, conditional operators. The break statement, the continue statement, the goto statement.

Unit-5
Arrays and pointers: Arrays, declaration of one dimensional arrays, two dimensional arrays, pointers.

Unit-6
Structures: User defined data types, structures, array of structures, enumerated data type.

Unit-7
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-8
Searching and sorting: Bubble sort, selection sort, insertion sort, linear search and binary search.

Unit-9
Object and classes: class, types of accesses, difference between structure and classes, accessing members of a class, constructors, destructors.

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.*

MD 302 Numerical Analysis+ **(L3 -T1 -P0 -CH4 -CR 4)**

Unit-1

Definition and sources of errors, Propagation of errors, Error analysis, Sensitivity and conditioning, Stability and accuracy, Floating-point arithmetic and rounding errors.

Unit-2

Interpolation, extrapolation and inverse interpolation, Newton divided difference, Lagrange, Hermite interpolation. Finite differences, divided differences are their properties.

Unit-3

Spline interpolation, B-splines. Special emphasis on cubic spline. Curve fitting.

Unit-4

Numerical solution of algebraic and transcendental equations, Iterative methods, Theory of one point iterative method, Newton Raphson method, rate of convergence, multipoint iterative methods.

Unit-5

Solution of system of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Numerical solution of non-linear simultaneous equations, Newton's method.

Unit-6

Trapezoidal and Simpson's method and error, composite integration. Double integration. Integration formulae: Gauss, Gauss-Legendre, Gauss-Hermite and Gauss-Laguerre quadrature formulae; Newton's formula for repeated integration**.**

Unit-7

Solution of ordinary differential equations. Picard method, Euler method, backward Euler method, modified Euler method, Runge-kutta class of methods.

Unit-8

Solving problems with C codes.

Textbook(s)

1. Atkinson, K.E. *Introduction to Numerical Analysis* (John Wiley, 1989)
2. 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)

Reference book(s)

1. Sastry, S.S., *Introductory methods of Numerical Analysis* (Prentice Hall of India, New Delhi, 1977).
2. Hilderbrand, F. B. *Introduction to Numerical Analysis*, (Tata McGraw Hill, New Delhi, 1974).
3. Conte, S. D., Boor, Carl de. *Elementary Numerical Analysis - An Algorithmic Approach*, 3rd Edition, (McGraw Hill, 1980).

+ *Practical unit for the course MD 302 to be done in the course MD 310 Computer Laboratory.*

MD 303 Real Analysis **(L3 – T1 – P0 - CH4 – CH 4)**

Unit-1
Elements of set theory, finite, countable and uncountable sets, Axiom of choice, Real number system.

Unit-2
Metric space, Open, closed sets, Interior, closure and boundary of sets, convergence of sequences, completeness, Cantor's Intersection Theorem, Baire category Theorem.

Unit-3
Continuity, Uniform continuity, open and closed maps, Homeomorphism.

Unit-4
Compactness in metric spaces, Bolzano Weiertrass Property, Lebesgue Number, Totally bondedness, Heine-Borel Theorem.

Unit-5
Connectedness, Components, Path connectedness, Intermediate Value theorem.

Unit-6
Riemann-Stieltjes integrals, properties, Mean value theorem, Fundamental theorem of calculus.

Unit-7
Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration.

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).

MD 304 Topology **(L3 -T1 -P0 -CH4 -CR 4)**

Unit-1
Topological spaces, basis and sub-basis, Subspaces, closure, interior and boundary.

Unit-2
Continuity, open functions, homeomorphisms, embeddings, strong and weak topologies.

Unit-3
Quotient and product spaces.

Unit-4
Countability axioms, separability, Lindelof spaces. Separation axioms (T_0, T_1, T_2, T_3, T_4), regularity, complete regularity, normality.

Unit-5
Compactness, local compactness, Tychonoff's product theorem, compactification.

Unit-6
Connectedness, local and path connectedness, components, products of connected spaces.

Textbook(s)

1. Kelley**,** J. L. *General Topology* (Graduate Texts in Mathematics, Vol. 27), (Springer, Berlin, 1991).
2. Munkres**,** J. R. *Topology : A first course* (2/e), (Prentice-Hall, 2000 or (1/e) Prentice Hall of India, New Delhi, 1983.)

Reference book(s)

1. Joshi**,** K. D. *Topology*, (Wiley-Eastern, New Delhi, 1988).

MD 305 Abstract Algebra (L3 -T1 -P0 -CH4 -CR 4)

Unit-1
Group: Definition, elementary properties of groups, order of an element, examples of groups, subgroups, examples of subgroups, subgroup tests, subgroup generated by a subset, cosets, properties of cosets, Lagrange's theorem.

Unit-2
Cyclic groups: Definition and examples, properties of cyclic groups, classification of subgroups of cyclic groups.

Unit-3
Permutation groups: Definition and notation, cycle notation, properties of permutation, even and odd permutations, generators for symmetric group Sn, alternating group An.

Unit-4
Group homomorphisms: Definition and examples, propertis of homomorphisms, normal subgroups, factor groups, isomorphisms, isomorphism theorems, Caley's theorem, automorphisms of groups.

Unit-5
Direct products: Definition and examples of external direct products, properties of external direct products, definition and examples of internal direct products, fundamental theorem of finite Abelian groups and applications.

Unit-6
Group Action: Definition and examples, properties of group action, class equation of finite groups, Sylow's theorems, applications of Sylow's theorems, normal series, and solvable groups.

Unit-7
Rings: Definition and examples, elementary properties of rings, subrings, ideals, factor rings, ring homomorphisms, definition and examples of fields, embedding theorems, polynomial rings, division algorithm, irreducible polynomials, finite fields, structure of finite fields.

Unit-8
Factorization theory in integral domains, PID, Euclidean domains, Gaussian domain, Separable and inseparable extension of fields, elements of Galois theory.

Textbook(s)
1. Gallian, J. A. *Contemporary Abstract Algebra*, 4th edition (Narosa Publishing house, New Delhi, 2009).
2. Dummit, D. S. & Foote, R. M. *Abstract Algebra*, 3rd edition (John Wiley & Sons, Indian reprint, New Delhi, 2011).
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 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 309 Computer Laboratory+ (L0-T0-P2 -CH4 -CR 1)

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

MD 310 Computer Laboratory+ (L0 -T0 -P2 -CH4 -CR 1)

+ *Practical unit for the course MD 302 Numerical Analysis+.*

MD 312 Complex Analysis (L3 -T1 -P0 -CH4 -CR 4)

Unit-1
Analytic functions, Cauchy-Riemann Equations, analyticity of elementary functions.

Unit-2
Complex integration, contour integrals, antiderivatives, Cauchy-Gaursat's theorem.

Unit-3
Cauchy integral formula, Morera's theorem, Maximum moduli of functions, Liouville's theorem, the Fundamental Theorem of Algebra.

Unit-4
Convergence of sequences and series, Taylor series, Laurent series.

Unit-5
Classification of singularities, Residue's, Cauchy Residue Theorem.

Unit-6
Evaluation of improper integrals and definite integrals involving sines and cosines, integration through a branch cut.

Unit-7
Logarithmic residues and Rouches theorem, the Argument Principle.

Unit-8
Linear fractional transformations, cross ratios, mappings of the half planes and circles, conformal mapping.

Unit-9
Condition under which a function is identically zero, Schwarz Reflection Principle, Analytic continuation, Riemann Surfaces.

Textbook(s)

1. Churchill, R. V. and Brown, J.W., *Complex Variables and Applications*, 8th Edition (McGraw-Hill Publishing Company, New Delhi, 2008).
2. Conway, J. B.**,** *Functions of One Complex Variable*, 2nd Edition (Narosa Publishing House, India, 1994).

Reference book(s)

1. Ahlfors, L. V., *Complex Analysis*, 3rd Edition (McGraw-Hill Publishing Company, New Delhi, 1979).
2. Priestly, H.A. *Introduction to Complex Analysis*, 2nd Edition (Cambridge, 2008).