COURSE CURRICULA

L = Lecture,   T = Tutorial,   P = Practical,   C = Credits

M.Sc. (MATHEMATICS)

1st Year

Ist Semester

Course Number	Course Name	L	T	P	C
MA 501	Linear Algebra	3	1	0	4
MA 502	Real Analysis-I	3	1	0	4
MA 503	Mechanics	3	1	0	4
MA 504	Differential Equations	3	1	0	4
MA 505	Abstract Algebra	3	1	0	4
MA 506	C++ Computer Programming	0	0	4	2
	Total	15	5	4	22

IInd Semester

Course Number	Course Name	L	T	P	C
MA 507	Topology	3	1	0	4
MA 508	Mathematical Statistics	3	1	0	4
MA 509	Numerical Analysis	3	1	0	4
MA 510	Operations Research-I	3	1	0	4
MA 511	Complex Analysis	3	1	0	4
MA 512	Computing Lab-I	0	0	4	2
	Total	15	5	4	22

2nd Year

IIIrd Semester

Course Number	Course Name	L	T	P	C
MA 601	Functional Analysis	3	1	0	4
MA 602	Discrete Mathematics	3	1	0	4
	Elective	3	1	0	4
	Elective	3	1	0	4
MA 603	Computing Lab-II	0	0	4	2
MA 604	Seminars	0	0	0	2
	Total	12	4	4	20

IVth Semester

Course Number	Course Name	L	T	P	C
MA 605	Differential Geometry	3	1	0	4
MA 606	Real Analysis-II	3	1	0	4
	Elective	3	1	0	4
	Elective	3	1	0	4
MA 607	Computing Lab-III	0	0	4	2
	Project	0	0	0	8
	Total	12	4	4	26
	Grand Total	54	18	16	90

Total Contact Hours: 88
Total Credits: 90

ELECTIVES

MA 608	Numerical Solution of Differential Equations
MA 609	Fuzzy Set Theory & Applications
MA 610	Computer Graphics
MA 611	Theory of Elasticity
MA 612	Number Theory
MA 613	Mathematical Theory of Finite Elements
MA 614	Information & Coding Theory
MA 615	Fluid Mechanics
MA 616	Theory of Wavelets
MA 617	Advanced Matrix Theory
MA 618	Finite Element Methods for Partial Differential Equations
MA 619	Probability Theory
MA 620	Operations Research-II
MA 621	Mathematical Methods
MA 622	Measure Theory
MA 623	Banach Algebras
MA 624	Harmonic Analysis
MA 625	Graph Theory
MA 627	Descriptive Statistics
MA 628	Sampling Distribution and Estimation Theory
MA 629	Sampling Techniques

MA-501 Linear Algebra

L T P C
3 1 0 4

Linear transformation, rank and nullity of a linear transformation, Sylvester's law of nullity, subspaces, quotient spaces, Schauder basis.

Algebra of linear transformations, orthogonal and supplementary linear transformations, dual space, linear functional, bidual, canonical isomorphism.

Matrix of a linear transformation, change of basis, equivalent and similar matrices, minimal polynomials, invertible linear transformation.

Eigen values, eigen vectors, more on maximal polynomials, Jordan block, Jordan canonical form, cyclic linear transformation, cyclic spaces, Jordan normal form.

Trace and transpose of a linear transformation, adjoint, hermitian, unitary and normal linear transformations.

Books Recommended:

1. P R Halmos, "Linear Algebra Problems Book", The Mathematical Association of America, 1996.

2. I N Herstein, "Topics in Algebra", Ginn & Co., 1964.

3. I N Herstein and D J Winter, "Matrix Theory and Linear Algebra", Macmillan Pub. Co., 1988.

4. K Hoffman and R Kunze, "Linear Algebra", Prentice Hall of India Pvt. Ltd., New Delhi, 1991.

5. C R Johnson, C L David, A L Porter and D Carlson, "Linear Algebra Gems: Assests for Undergraduate Mathematics", The Mathematical Association of America, 2002.

MA-502   Real Analysis-I

	L	T	P	C
	3	1	0	4

Ordered sets, euclidean spaces, open and closed sets, neighborhoods, closure, limit point of a set, finite, countable and uncountable sets, metric spaces, compact metric spaces, connected metric spaces and perfect sets.

Definition and examples of metric spaces, open and closed spheres, open and closed sets, convergence completeness, Cantor's intersection theorem, dense sets and separable spaces, Baire's category theorem, continuous mappings, homeomorphism, uniform continuity.

Numerical sequences and series, pointwise and uniform convergence, subsequences, Cauchy sequences, absolute convergence, power series, Sequences and series of functions, uniform convergence, continuity, integration and differentiation, Weierstrass theorem,

Functions of several variables, inverse and implicit functions, derivatives of higher order, Taylor's theorem, differentiation of vector valued functions, differentiation of integrals, multiple integration, change of variables.

Books Recommended:

1. T. M. Apostol, "Mathematical Analysis", Narosa Publishing House, 1985.

2. W. Rudin, "Principles of Mathematical Analysis", Mc-Graw Hill, 1976.

MA-503   Mechanics

	L	T	P	C
	3	1	0	4

Moments of inertia, kinetic energy, angular momentum.

Mechanics of a particle and system of particles, kinematics of a rigid body, Euler's angles.

Euler's dynamical equations, two dimensional motion of a rigid body, compound pendulum, constraints.

D'Alembert's principle, Langrange's equation of motion, techniques of calculus of variations, Hamilton's principles.

Hamilton's equation of motion, contact transformation, Lagrange's and Poisson brackets, integral in variances, Hamilton-Jacobi-Poisson equations.

Books Recommended:

1. F Chorlton, "A Text Book of Dynamics", CBS Publishers, 1985.

2. C Fox, "An Introduction to the Calculus of Variations", Dover Publications, New York, 1987.

MA-504   Differential Equations

L T P C
3 1 0 4

Review of power series, existence and uniqueness of solution of first order equations, equations with variables separated, exact equations, method of successive approximations, Lipschitz condition, convergence of successive approximation, approximations and uniqueness of solutions, two point boundary value problem, Fourier series, the Fourier convergent theorem, separation of variables, Laplace's equation, the occurrence of two point boundary value problems, Strurm Lioville boundary value problems, non homogeneous boundary value problem, singular Strum Lioville problems, Bessel series expansion, series of orthogonal functions, mean convergence.

Ordinary differential equations in more than 2-variables, surfaces and curves in three dimensions, simultaneous differential equations of first order and first degree in three variables, method of solution of dx/P=dy/Q=dz/R, orthogonal trajectories of a system of curves on a surface, Pfaffian differential forms and equation, solution of Pfaffian differential equations in three variables, Caratheodory's theorem.

Partial differential equations, Cauchy's problem for first order equations, linear equations of first order, integral surface passing through a given curve, surfaces orthogonal to a given system of surfaces, Nonlinear partial differential equations of first order, Cauchy's method of characteristics, compatible systems of first order equations, Charpit's method, special types of first order equations, jacobi's method.

Applications of first order equations, partial differential equations of higher order with constant co-efficients, linear differential equations with constant coefficients, equations with variable coefficients, characteristics curves of second order equations, characteristics of equations in three variables, solution of linear hyperbolic equations, separation of variables, method of integral transforms, nonlinear equations of second order.

Books Recommended:

1. W E Boyce and R C Diprima, " Elementary Differential Equations and Boundary   Value Problems ", John Wiley and Sons, USA, 2004.

2. E A Coddington, "An Introduction to Ordinary Differential Equations", Prentice-Hall of India ,New Delhi, 2002.

3. I N Sneddon, " Elements of partial Differential Equations", McGraw Hill, 1957.

MA-505   Abstract Algebra

L   T   P   C
3   1   0   4

Groups, subgroups, quotient groups, homomorphism, permutation groups, automorphisms of groups and structure of cyclic groups, conjugate elements.

Direct products, Sylow's theorems, finite Abelian groups, generators of a subgroup and derived subgroups, normal series, solvable groups and Jordan-Holder theorem, survey of some finite groups.

Rings, subrings and ideals, algebra of ideals, quotient rings, homomorphisms, field of Quotients and embedding theorems.

Polynomial rings, factorization in R[x], divisibility, euclidean domains, unique factorization domains.

Fields, subfields and prime fields, extension of fields.

Books Recommended:

1. Surjeet Singh and Qazi Zameeruddin, "Modern Algebra", Vikas Publishing House Pvt. Ltd. 1972.

2. S Luther and I B S Passi, "Algebra, Vol. 1-Groups, Vol. 2-Rings", Narosa   Publishing House, 2003.

3. I N Herstein, "Topics in Algebra", Vikas Publishing House Pvt.Ltd.,1971.

4. Neil Henry and N H Mc-Coy, "Theory of Rings", Chelsea Publishing   Company, 1973.

MA-506   C++ Computer Programming

	L	T	P	C
	0	0	4	2

Introduction to C++ programming, identifiers and keywords, integer and real operations, declarations, input output statements, operators, expressions and library functions, conditional statements, integer types, control statements, if else statements, switch statements, while statements, for statements, nested loops, break statements, continue statements, functions and overloading, arrays, pointers and references, structures and unions, data files.

Books Recommended:

1. J J Barton and L R Nackman, "Scientific and Engineering C++", Addison-Wesley Publishing Company, MA, 1994.

2. S C Dewhurst and K T Stark, "Programming in C++", Prentice Hall, NJ, 1995.

3. R Johnsonbaugh, and M Kalin, "Objected oriented Programming in C++", Prentice Hall, NJ, 1995.

MA 507   Topology

	L	T	P	C
	3	1	0	4

Topological spaces, neighbourhood system of a point, limit points, closed set, closure, interior, exterior and boundary, bases and sub bases, continuity, homeomorphism, sub spaces and product spaces, local base, first and second countable spaces, separable spaces, second countability and separability, Lindelof's theorem.

Compactness, continuous functions and compact sets, finite intersection property, Heine Borel theorem, locally compact spaces, countable compactness, sequential compactness, Bolzeno Weierstrass property, Lebesgue converting lemma, total boundedness, equivalence of compactness.

Separation axioms, T_i (i =0, 1, 2, 3, 4) spaces, regular and completely regular spaces, normal and completely normal spaces, Urysohm's lemma, Tietze extension theorem.

Connected spaces, components, locally connected spaces, totally connected spaces, totally disconnected spaces, pathwise connectivity.

Books Recommended:

1. G F Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Company, 1963.

2. J L Kelley, "General Topology", Van Nastrand, Reinhold Co., New York, 1995.

3. W J Pervin, "Foundations of General Topology", Academic Press Inc. New York, 1964.

MA-508   Mathematical Statistics

L T P C
3 1 0 4

Different approaches to probability, addition and multiplication theorem of probability, Boole's inequality, conditional probability, Bayes theorem and applications.

Random variables, distribution function and its properties, discrete and continuous random variables, two dimensional random variables, transformation of one and two dimensional random variable, mathematical expectation, addition and multiplication theorem of expectation, expected value of a random variable, properties of variance, moment generating function.

Binomial, Poisson, negative binomial, geometric distribution, uniform, exponential, normal, Gamma and Beta distributions.

Concept of statistics, collection and representation of data, frequency distribution, graphical representation of data, measure of central tendency and dispersion, coefficient of dispersion, moments, factorial moments, skewness and kurtosis.

Regression between two variables, karl-Pearson correlation coefficient and rank correlation, multiple regressions, partial and multiple correlation (three variables case only).

Books Recommended:

1. V K Rohatgi "Introduction to Probability Theory and Mathematical Statistics", Wiley Eastern, 1976.

2. A M Goon, M K Gupta and B Dasgupta, "An Outline of Statistical Theory Vol. I",The World Press Pvt. Ltd, 1983.

3. R V Hogg and A T Craig, "Introduction to Mathematical Statistics", Pearson Education, 2007.

4. S C Gupta and V K Kapoor, "Fundamental of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 1970.

MA-509   Numerical Analysis

L T P C
3 1 0 4

Approximation and errors, bisection method, regula-falsi method, Newton-Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of simultaneous algebraic equations, matrix inversion and eigen value problems, triangularisation method, Jacobi's and Gauss-Siedel iteration methods, Newton-Raphson method for nonlinear simultaneous equations, triangularisation method for matrix inversion, partition method for matrix inversion, power method for largest eigen-values and Jacobi's method for finding all eigen-values.

Forward, backward, central differences formulae and relations between them, forward, backward, central and divided difference interpolation formulae, Lagrange's interpolation formula, Spline interpolations and B-splines.

Trapezoidal rule, Simpson's one-third rule and numerical double integrations using Trapezoidal rule and Simpson's one-third rule, Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods for ordinary differential equations, methods for solving simultaneous first and second order differential equations, finite difference methods for boundary value Problems, finite difference methods for elliptic, parabolic and hyperbolic partial differential equations.

Books Recommended:

1.   W F Ames, "Numerical Methods for Partial Differential Equations", Academic Press, New York, 1992.

2.   G Dahlquist, and A Björck, "Numerical Methods", Prentice-Hall, NJ 1974.

3.   M K Jain, S R K Iyengar and R K Jain, "Numerical Methods for Scientific and Engineeing Computations", New Age International (P) Limited, Publishers, New Delhi, 2003.

4.   G W Stewart, "Introduction to Matrix Computations", Academic Press, New York, 1973.

MA-510   Operations Research - I

L T P C
3 1 0 4

Introduction of Operations Research, review of matrices, vectors and vector inequalities, linear combination of vectors, hyperplanes and hyperspheres, convex sets and their properties.

Linear programming problem, mathematical formulation, graphical method, general linear programming problem, standard and canonical forms of LPP.

The simplex method, basic feasible solutions, extreme point solutions, fundamental properties of basic feasible solutions, simplex method of solving LPP, artificial variable techniques, big-M method, two phase method, problem of degeneracy.

Duality in linear programming, concept of duality, formulation of primal-dual pairs, duality theorems, dual simplex method, sensitivity analysis.

Revised simplex method and bounded variable technique.

Transportation problem, mathematical formulation of the problem, triangular basis, loops in a transportation table, finding initial basic feasible solution, moving towards optimality, degeneracy in transportation problem, unbalanced transportation problems. Assignment problem, mathematical formulation and Hungarian method for its solution.

Sequencing problem, problem of sequencing, problems with n jobs and 2 machines, problems with n jobs and k machines, problems with 2 jobs and k machines.

Games and strategies, two person zero sum games, the maximin and minimax principles, games without saddle point, mixed strategies, solution of (2x2) rectangular games, graphical method, dominance property, the linear programming method.

Books Recommended:

1. A. Ravindran, D T Philips, J J Solberg ,"Operations Research", John Wiley and Sons, 1987.

2. H A Taha, "Operations Research - An Introduction", Prentice-Hall of India, 2005.

3. G Hadley, "Linear Programming", Narosa Publishing House, New Delhi, 1987.

4. Kanti Swarup, P K Gupta and M M Singh, "Operations Research", Sultan Chand & Sons, New Delhi, 2005.

MA-511   Complex Analysis

	L	T	P	C
	3	1	0	4

Analytic functions, Cauchy Riemann equations, power series, some elementary functions, harmonic functions.

Properties of line integral, zeroes of an analytic function, Cauchy's theorem, Cauchy's integral formula, Cauchy's inequality, fundamental theorem of algebra, Poisson's formula, Liouville's theorem, Rouche' theorem, the argument principle.

Residues and poles, classifications of isolated singularities, Taylor's and Laurent's series, winding numbers, Cauchy residue theorem.

Application of Cauchy residue theorem for evaluation of improper real integrals and evaluation of sum.

Conformal mapping and their properties, Schwarz's lemma, Riemann mapping theorem, maximum modulus theorem, analytic continuation.

Books Recommended:

1. L V Ahlfors, "Complex Analysis", McGraw Hill,1979.

2. J B Conway, "Functions of One Complex Variables", Narosa Publishing House, 1980.

3. S Lang, "Complex Analysis", Springer-Verlag, 2003.

4. W Rudin, " Real And Complex Analysis", McGraw Hill,1966.

5. W Tutschke and H L Vasudeva, "An Introduction to Complex Analysis: Clasical and Modern Approaches (Modern Analysis Series)", Chapman and Hall/CRC, 2004.

MA-601   Functional Analysis

L T P C
3 1 0 4

Definition and examples of normed and Banach spaces, the classical Banach space L_p, subspaces and quotient spaces, continuous linear transformations, equivalent norms, Riesz-lemma, linear functional and the Hahn Banach theorem, the natural imbedding of N into N^{**}, the open mapping theorem, projections on Banach spaces, the closed graph theorem, uniform bounded principle, the conjugate of an operator.

Inner product and Hilbert spaces, orthogonal complements, orthogonal sets, the conjugate space H^*, the adjoint of an operator, self adjoint operators, normal and unitary operators, projections.

Finite dimensonal spectral theory, eigenvalues and eigen vectors, existence of eigenvalues, matrix of a linear transformation, the spectral theorem.

Books Recommended:

1. S K Berberian, "Introduction to Hilbert Space", Chelsea Publishing Company, 1961.

2. T Furuta, "Invitation to Linear Operators", Taylor and Franics, London, 2001.

3. E Kreyszig, "Introductory Functional Analysis with Aplications", John Wiley & sons, NY, 1978.

4. G F Simmons, "Introduction to Topology and Modern Analysis", Tata McGraw   Hill, 2005.

MA-602   Discrete Mathematics

L T P C
3 1 0 4

Relations, recursion, recurrence relations, linear homogeneous recurrence relations, solution of recurrence relations.

Partially ordered sets, different types of lattices, Boolean algebra, Boolean expressions, logic, networks, Karnaugh maps, application of Boolean algebra to switching theory.

Directed graphs, undirected graphs, matrices, relations and graphs, paths and circuits, Eulerian and Hamiltonian graphs, planar, connected graphs.

Trees, properties of trees, rooted trees, spanning trees, minimum spanning trees, binary tree, tree traversals.

Linear codes, error detection and correction, hamming distance and hamming weights, maximum-likelihood decoding, syndrome decoding, perfect code, the sphere packing bound, cyclic codes.

Books Recommended:

1. K A Ross and G R Wright, "Discrete Mathematics", Prentice Hall of India, 2003.

2. C L Liu," Elements of Discrete Mathematics", McGraw Hill Publishing Co, 1985.

3. Narsingh Deo, "Graph theory with applications to Engineering & Computer Science", Prentice Hall of India,1994.

MA-605   Differential Geometry

	L	T	P	C
	3	1	0	4

Curves with torsion, principal normal, binormal, Serret–Frenet formulae, spherical curvature, curves determined by its intrinsic equations, helices, involutes, evolutes, Bertrand curves.

Envelopes, developable surfaces, one parameter family of surfaces, envelope characteristics, edge of regression, developables associated with a curve, osculating developable, polar developable, rectifying developable, two parameter family of surfaces, envelope characteristic points.

Curvilinear coordinates on a surface, first order magnitudes, second order magnitudes, curvature of normal section, Meunier's theorem.

Curves on a surface, lines of curvature, first and second curvatures, Euler's theorem, Dupin's indicatrix, surface of revolution, conjugate directions, conjugate systems, asymptotic lines, isometric lines, null lines.

Equations of Gauss and Codazzi, Gauss's formulae, Gauss characteristic equation, Mainardi – Codazzi relations, Bonnet's theorem.

Geodesics and geodesic parallels, geodesic property, equations of geodesics, torsion of a geodesic, curves in relation to geodesics, Bonnet's theorem, Joachimsthal's theorem, vector curvature, geodesic curvature, geodesic distance, geodesic polar coordinates, total second curvature of a geodesic triangle, theorem on geodesic parallels, geodesic ellipses and hyperbolas, Liouville surfaces.

Books Recommended:

1. C E Weatherburn, "Differential Geometry", Khosla Publishing House, New Delhi, 2002.

2. T J Willmore, "An Introduction to Differential Geometry", Oxford University Press, 1959.

3. P G Ciarlet, "An Introduction to Differential Geometry", Springer, 2006.

MA-606   Real Analysis-II

L T P C
3 1 0 4

Measurable sets, outer measure, Lebesgue measure, properties of measurable sets, borel sets and their measurability, non measurable sets.

Definition and properties of measurable functions, step functions, characteristic functions, simple functions, Littlewood's three principles.

Lebesgue integral of a bounded function, comparison of Reimann and Lebesgue integrals, integral of a non-negative function, general Lebesgue integral, convergence in measure.

Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity.

The L^p -spaces, Holder's and Minkowski's inequalities, convergence and completeness, Riesz-Fisher theorem, bounded linear functionals on the L-spaces, Riesz representation theorem.

Books Recommended:

1. P R Halmos, "Measure Theory", Springer-Verlag, 1978.

2. P K Jain and V P Gupta, "Lebesgue Measure and Integration", Wiley Eastern, 1986.

3. H L Royden, "Real Analysis", Macmillan Company, 1968.

MA-608   Numerical Solution of Differential Equations

L T P C

3 1 0 4

Initial value problems for systems of ordinary differential equations, Taylor series method, Euler,s metod, Modified Euler's method, Runge-Kutta methods (explicit, implicit), order of convergence, stability, extrapolation.

Predictor-Corrector methods, Adams-Bashforth method, Adams-Moulton method, Nyström's method, Milne-Simpson method, convergence, stability, linear multistep methods for second order equations, finite difference methods of second and fourth order for boundary value problems, eigen value problems.

Routh- Hurwitz criterion, difference methods for parabolic partial differential equations, one and two space dimensions, second and fourth order methods, spherical and cylindrical coordinate systems, nonlinear equations, convergence and stability.

Difference methods for hyperbolic equations, one and two space dimensions, second and fourth order methods, convergence and stability, systems of first order equations.

Rectangular and polar systems, second and fourth order mehods for elliptic partial differential equations, difference methods for linear boundary value problems, general second order linear equations, quasilinear elliptic equations.

Books Recommended:

1. W F Ames, "Numerical Methods for Partial Differential Equations", Academic   Press, New York , 1992.

2. P Henrici, "Discrete Variable Methods in Ordinary Differential Equations", John Wiley and Sons, New York, 1962.

3. M K Jain, "Numerical Solution of Differential Equations", Wiley Eastern, New Delhi, 1984.

4. M K Jain, S R K Iyengar and R K Jain, "Computational Methods for Partial   Differential Equation ", Wiley Eastern, New Delhi, 1994.

MA-609   Fuzzy Set Theory and Applications

L	T	P	C
3	1	0	4

Fuzzy sets versus crisp sets, Representation of Fuzzy sets, extension principle for Fuzzy sets.

Fuzzy complements, Fuzzy intersections, Fuzzy unions, Fuzzy numbers, arithmetic operations, Fuzzy intervals and numbers, Fuzzy equations.

Crisp versus Fuzzy relations, projections and culindric extensions, binary Fuzzy relations, Fuzzy equivalence relations, Fuzzy compatibility relation, Fuzzy odering relations, Fuzzy morphisms, Fuzzy relation equations.

Fuzzy measure, evidence theory, Fuzzy sets and possibility theory, possibility theory versus probability theory.

Multivalued logic, Fuzzy propositions, Fuzzy quantifiers, linguistic hedges, inference from quantified propositions, information and uncertainty, nonspecificity of crisp and Fuzzy sets, uncertainty in evidence theory, principles of uncertainty.

Books Recommended:

1. A Billot, "Economic Theory of Fuzzy Equilibria: An Axiomatic Analysis", Springer Verlag, 1992.

2. S J Chen and C L Hwang, "Fuzzy Multiple Attribute Decision Making: Methods and Applications", Springer Verlag, New York, 1992.

3. E Cox, "The Fuzzy Systems Handbook", Academic Press, Cambridge, MA, 1994.

4. D Dubois and H Prade, "Fuzzy Sets and Systems: Theory and Applications",   Academic Press, New York, 1980.

5. J K Goerge and B Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and   Applications", Prentice Hall of India, 2002.

MA-610   Computer Graphics

L T P C
3 1 0 4

Graphics input devices, output devices, display devices, video controller, graphics controller, raster scan display processor, scan converting lines, rectangles, circles, ellipses, arcs and sectors, Bresenham algorithm, midpoint algorithms for line and circles.

Boundary fill, flood fill, scan line polygon fill algorithm, 2D transformations, 3D transformations, matrix representations of 2D transformations and 3D transformations, homogeneous coordinates, translations, rotations, composition of 2D and 3D transformations.

Window-to-viewport transformations, Cohen Sutherland and Liang-Barskey algorithms, polygon clipping, Hodgeman algorithm, Wieler-Atherton algorithms, perspective projection, parallel projection.

Polygon surfaces, curved surfaces, parametric curves, spline curves, B-spline curves, Bezier surfaces, spline surfaces, algorithms for visible line deteremination, Z-buffer algorithm, list priority algorithm, scan line algorithm, visible ray tracing, Painter's algorithm, subdivision algorithm, illumination models, shading models for polygons.

Books Recommended:

1. J Foley, A Dam, Van, S Feiner, and J Hughes, "Computer GraphicsPrinciples   and Practice*",* Pearson Education, 2003.

2. D Hearn and P Baker, " Computer Graphics*",* Pearson   Education, 2006.

3. R Plastock and G Kalley, "Theory and Problems of Computer Graphics", Tata Mcgraw-Hill, 2002.

4. D Rogers and J Adams," Mathematical Elements for Computer Graphics*",* Tata McGraw Hill, International Student Edition, 1990.

MA-611   Theory of Elasticity

L   T   P   C
3   1   0   4

Coordination transformation, cartesian tensor of different order, sum , difference and product of two tensors, contraction theorem, quotient law, symmetric and skew symmetric tensors, kronecker tensor and alternate tensor and relation between them, scalar invariant of second order tensor, eigen values and vectors of a symmetric second order tensor, gradient, divergence and curl of a tensor field.

Affine transformation, infinitesimal affine deformation, geometrical interpretation of the components of strain, strain quadratic of Cauchy, principal strains and invariant, general infinitesimal deformation, Saint-Venant's equations of compatibility, finite deformations.

Stress tensor, equations of equilibrium, transformations of coordinates, stress quadratic of Cauchy principal stress and invariant, maximum normal and shear stress.

Generalised Hookes law, homogeneous isotropic media, elasticity modulii for isotropic media, equilibrium and dynamic equations for an isotropic elastic solid, strain energy function and its connection with Hookes law, uniqueness of solution, Beltrami –Michell compatibility equations, Saint-Venant's principal.

Torsion of cylindrical bars, torsional rigidity, torsion and stress functions, lines of shearing stress, simple problems related to circle, ellipse and equilateral triangle.

Books Recommended:

1. I S Sokolnikoff, "Mathematical Theory of Elasticity", Tata – Mcgraw Hill Publication Co. Ltd, New Delhi,1983.

2. A E Love, "A Treatise on the Mathematical Theory of Elasticity", Cambridge Press, London, 1952.

MA-612   Number Theory

L	T	P	C
3	1	0	4

Divisibility, G.C.D and L.C.M., primes, Fermates numbers, congruencies and residues, theorems of Euler Fermates and Wilson, solutions of congruencies , linear congruencies, Chinese remainder theorem ,Euler function $\varphi(n)$, congruences of higher degree, congruences of prime power modulla and prime modulus, power residue, quadratic residue, Legendre symbols, lemma of Guass and reciprocity law. Jacobi symbols, Farey series, rational approximation, Hurwitz theorem, irrational numbers, Iirationality of e.

Representation of the real numbers by decimals, finite continued fractions, simple continued fractions, infinite simple continued fractions, periodic continued fractions, approximation by convergence, best possible approximation, Pells equations.

Diophantine equations $ax + by = c$, $x^2+y^2 = z^2$ and $x^4 +y^4 = z^4$, arithmetical functions $\varphi(n)$, $\mu(n)$ and d(n)and $\sigma(n)$ mobius inversion formula, perfect numbers, waring problems, numbers g(k) and G(K), Lagrange four sphere theorem, value of g(2) and G(2), elementary results on distribution of primes, prime number theorem.

Books Recommended:

1. G H Hardy and E M Wright, "Theory of Numbers", Oxford Science Publications, 2003.

2. I Niven and H S Zuckerman, "Introduction to the Theory of Numbers", John Wiley & Sons,1960.

3. D M Burton, "Elementary Number Theory", Tata McGraw Hill Publishing House, 2006.

MA-613   Mathematical Theory of Finite Elements

L T P C

3 1 0 4

One dimensional finite elements, mathematical equations of engineering, variational functions, interpolation functions, shape functions, stiffness matrix, connectivity, boundary conditions, problems in cylindrical coordinate, the direct method.

Two dimensional finite element   methods, two dimensional boundary value problems, connectivity and nodal coordinates, theory of elasticity, variational functions, triangular elements and area coordinates, transformations, cylindrical coordinates.

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Variational principles, Ritz method, Galerkin approximation, numerical integration, interpolation formulas and shape function formulas, generalized coordinates, isoprametric elements, axisymmetric formulations.

Three dimensional finite elements, higher order finite elements, element continuity, plate finite elements, application of finite element methods to elasticity problems and heat transfer problems.

Books Recommended:

1.   K J Bathe, ” Finite Element Procedures”, Prentice Hall, 2002.

2.   W B Bickford, “A first course in the Finite Element Method”*,* Irwin Boston, 1990.

3.   G R Buchanan, “ Finite Element Analysis”, Mc Graw Hill, 1995.

4.   J N Reddy, ” An Introduction to Finite Element Method*”,* McGraw Hill, 1993.

MA-614   Information and Coding Theory

L T P C
3 1 0 4

Source coding, uniquely decodable codes, instantaneous codes, Kraft's inequality, McMillan's inequality, optimal codes, binary Huffman codes, extensions of sources.

Information and entropy, properties of entropy function, entropy and average word-length, Shannon-Fano coding, entropy of extensions and products, Shannon's first theorem.

Information channels, the binary and symmetric channel, system entropies, mutual information for binary symmetric channel, unreliable channel, decision rules, Hamming distance.

Error-correcting codes, Hamming sphere, packing bound, the Gilbert-Varshamov bound, hadamard matrices and codes.

Linear codes, matrix description of linear codes, minimum distance of linear codes, the Hamming and Golay codes, syndrome decoding.

Books Recommended:

1. R Hill, "A First Course in Coding Theory", Oxford University Press, 1986.

2. D S Jones, "Elementary Information Theory", Oxford University Press, 1979.

3. G A Jones and J M Jones, "Information and Coding Theory", Springer Verlag, 2004.

4. J H van Lint, "Introduction to Coding Theory", Springer Verlag, 1982.

5. V S Pless and W Huffman, "Handbook of Coding Theory", Elsevier Amsterdam, 1998.

MA-615   Fluid Mechanics

L   T   P   C
3   1   0   4

Lagrangian and Eulerian methods, equations of continuity, stream lines, path lines and streak lines, velocity potential and stream function, irrotational and rotational motions.

Euler's equation, Bernoulli's equation, equations referred to moving axes, impulsive actions, vortex motion and its elementary properties, motions due to circular and rectilinear vortices, Kelvin's proof of permanence.

Irrotational motion in two dimensions, complex – velocity potential sources, sinks, doublets and their images, conformal mapping.

Stress components in a real fluid, Navier–Stokes equations of motion, Plane Poiseiuille and Coquette flows between two parallel plates, flow through a pipe of uniform cross section in the form of circle, annulus, theory of lubrication.

Boundary layer thickness, displacement thickness, Prandit boundary layer, boundary layer equations in two dimensions, Blasius solutions, Karmal integral equation, separation of boundary layer flow.

Books Recommended:

1. S W Yuan, " Foundations of Fluid Mechanics", Prentice Hall of India Private Limited, New Delhi, 1967.

2. F Chorlton, " Textbook of Fluid Dynamics", C.B.S Publishers, New Delhi,1985.

3. W H Basant and A S Ramsay, " Treatise of Hydro Mechanics Part II", C.B.S Publishers, New Delhi, 1972.

4. R K Rathy, " An Introduction to Fluid Dynamics", Oxford and IBH publishing Company, New Delhi, 1976.

MA-616   Theory of Wavelets

L   T   P   C
3   1   0   4

The origin of wavelets, wavelets and other reality transformations, functions and function spaces, orthogonality and the method of finding the coefficients, complex Fourier series, orthogonality of complex exponential bases.

Continuous wavelet and short time Fourier transformation, continuous time frequency representation of signals, the windowed Fourier transformation, the uncertainty and the time frequency tiling, properties of wavelets used in continuous wavelet transformations.

Discrete wavelet transformation, Haar scaling functions and functions spaces, Haar wavelet function, support of a wavelet system.

Designing orthogonal wavelet systems, orthogonality of scaling and wavelet functions, approximation conditions, designing Daubechies orthogonal wavelet system coefficients.

Discrete wavelet transformation and relation to filter banks, frequency response, signal construction, upscaling and filtering, perfect matching filters.

Books Recommended:

1. K P Soman and K I Ramachandran, "Insight into Wavelets: From Theory to Practice", Prentice Hall of India, 2005.

2. J Walker, "Premier on Wavelets", Chapman and Hall/CRC, 1999.

MA-617   Advanced Matrix Theory

L T P C
3 1 0 4

Convex and concave functions, basic properties, characterizations, log-convex functions, inequalities involving convex functions and applications, sub/super-additive functions, relation between convex/concave functions and sub/super-additive functions.

Positive definite matrices, properties and characterizations, the polar decomposition, singular value decomposition, min-max principle, norms of matrices, Ky-Fan norms, eigen and singular values inequalities.

Matrix functions, eigenvalues inequalities for convex and concave matrix functions, sub/super additive inequalities for matrix functions.

Matrix monotone functions, matrix convex and concave functions, simple examples and applications to norm inequalities.

Books Recommended:

1.   R Bhatia, "Positive Definite Matrices", Princeton University Press, 2007.

2.   R Bhatia, "Matrix Analysis", Springer Verlag, New York, 1997.

3.   R A Horn and C R Johnson, "Matrix Analysis", Cambridge University Press, 1988.

4.   R A Horn and C R Johnson, "Topics in Matrix Analysis", Cambridge University.Press, 1991.

5.   A W Roberts and D E Varberg, "Convex Functions", Academic Press New York, 1973.

MA-618   Finite Element Method for Partial Differential Equations

L   T   P   C

3   1   0   4

Variational principles, stable equilibrium problem, boundary conditions, mixed variational principles, time dependent variational principles, dual variational principles.

Methods of approximation, Ritz method, boundary condition, Kantorovich method, Galerkin method, projection method.

Basis functions, triangle, rectangle, quadrilateral tetrahedron, hexahedron, curved boundaries.

convergence of approximation, convergence of Galerkin approximation, approximation errors, perturbation error.

Books Recommended:

1. C De Boor, "Mathematical Aspects of Finite Element Method in Partial Differential Equations", Academic Press New York, 1974.

2. P G Ciarlet, "The Finite Element Method for Elliptic Problems*", North-Holland, Amsterdam, 1978.

3. C Johnson, " Numerical Solution of Partial Differential Equations by the Finite Element Method ", Cambridge University Press, 1987.

4. A R Mitchell and R Wait, "The Finite Element Method in Partial Differential Equations ", John Wiley & Sons, New York, 1978.

MA-619   Probability Theory

L	T	P	C
3	1	0	4

Review of axiomatic approach to probability and conditional probability, extension of addition and multiplication theorem, independent events and its properties.

Generating function, cumulants, characteristic function and its properties, probability generating function, Chebyshev's inequality, convolution.

Bi-variate probability distribution, marginal and conditional distribution, bi-variate normal distribution.

Convergence in probability, weak law of large numbers, strong law of large numbers, Bernoulli's law of large numbers, central limit theorem, Boral Cantelli lemma.

Sampling distribution, sampling distribution of Chi-square, t and F-distribution and their applications, point estimation, probabilities of point estimates, method of maximum likelihood, Interval estimation, confidence interval for mean and variance.

Testing of Hypothesis, fundamental notions, Nayman Pearson lemma, important tests based on normal, Chi-square, t and F-distribution.

Books Recommended:

1. V K Rohatgi "Introduction to Probability Theory and Mathematical Statistics" Willey Eastern, 1976.

2. A M Goon, M K Gupta and B Dasgupta, "An Outline of Statistical theory Vol. I "The World Press Pvt. Ltd, 1983.

3. R V Hogg and A T Craig, "Introduction to Mathematical Statistics" Pearson Education, 2007.

4. S C Gupta and V K Kapoor, "Fundamental of Mathematical Statistics" Sultan Chand & Sons, New Delhi,1970.

MA-620   Operations Research-II

L T P C
3 1 0 4

Integer programming problem, Gomory's all integer method, Gomory's mixed integer method, branch and bound method, zero-one programming problem.

Dynamic programming, the recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of LPP by dynamic programming.

Nonlinear programming, convex functions and their properties, general nonlinear programming problem, problem of constrained maxima and minima, graphical solution, saddle point problems, Wolfe's and complementary pivot algorithms for convex quadratic programming problems.

Queueing Theory, characteristics of queueing systems, Poisson process and exponential distribution, classification of queues, Poisson queues, M/M/1 and M/M/C queueing systems

Inventory and replacement problems, reasons for carrying inventory, types of inventory, the inventory decisions, economic order quantity, deterministic inventory problems, replacement of equipment or asset that deteriorates gradually and that fails suddenly.

Simulation, Network scheduling by CPM and PERT, Geometric programming.

Books Recommended:

1. A. Ravindran, D T Philips, J J Solberg ,"Operations Research", John Wiley and Sons, 1987.

2. H A Taha, "Operations Research - An Introduction", Prentice-Hall of India, 2005.

3. Kanti Swarup, P K Gupta and M M Singh, "Operations Research", Sultan Chand & Sons, New Delhi, 2005.

MA-621   Mathematical Methods

L   T   P   C
3   1   0   4

Gamma and Beta function, Euler production and Euler's integral for (z) Beta function, Legendre's duplication formula, Gauss multiplication theorem.

Hermite and Laguerre polynomials, generating functions, recurrence relations, Rodrigue formula, orthogonal properties, expansion of simple functions in a series of Hermite polynomials, Laguerre polynomials.

Laplace transforms, properties of Laplace transforms, convolution theorem, transform of elementary function and transforms of derivatives, inversion of Laplace transforms, application of Laplace transform to ordinary and partial differential equations.

Fourier transforms, sine and cosine transforms, Fourier integral theorem, inversion of Fourier transforms, application to ordinary and partial differential equations.

Books Recommended:

1. E D Rainvilla, "Special functions", Macmillion Co., New York,1971.

2. F B Hilderbrand, "Methods of Applied Mathematics", Dover Publication, New York, 1983.

3. I N Sneddon, "Fourier Transforms", McGraw Hill, New York,1950.

4. R K Jain and S R K Iyenger, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi, 2002.

MA-622   Measure Theory

L   T   P   C
3   1   0   4

Semi-algebra, algebra, monotone class, sigma-algebra, monotone class theorem, measure spaces.

Outline of extension of measures from algebras to the generated sigma-algebra, measurable sets, Lebesgue measure and its properties.

Measurable functions and their properties, integration and convergence theorems.

Introduction to L^p-spaces, Riesz-Fisher theorem, Riesz representation theorem for L^2-spaces, absolute continuity of measures, Radon-Nikodym theorem, dual of L^p-spaces.

Product measure spaces, Fubini's theorem, fundamental theorem of calculus for Lebesgue integrals.

Books Recommended:

1.   D L Cohn, "Measure Theory", Birkhauser, 1994.

2.   P R Halmos, "Measure Theory", Springer-Verlag, 1978.

3.   H L Royden, "Real Analysis", MacMillan, 1968.

MA-623 Banach Algebras

L	T	P	C
3	1	0	4

Defintion of Banach algebra and examples, singular and non-singular elements, the spectrum of an element, the spectral radius, Gelfand formula, multiplicative linear functionals, the maximal ideal space, Gleason-Kahane-Zelazko theorem.

The Gelfand transforms, the spectral mapping theorem, isometric Gelfand transform, maximal ideal spaces for disc algebra, the algebra $1_1(Z)$.

C^*-algebras, self adjoint, unitary, normal, positive and projection elements in C^*-algebras, commutative C^*-algebras, C^*-homomorphisms, representation of commutative C^*-algebras, sub-algebras and the spectrum, the spectral theorem, the continuous functional calculus, positive linear functionals and states in C*-algebras.

Books Recommended:

1. W Arveson, "Introduction to C^* Algebras", Springer Verlag, 1976.

2. T W Palmer, "Banach Algebra Vol. I", Cambridge University Press, 1994.

3. K Zhu, "An Introduction to Operator Algebras", CRC Press Inc., 1993.

MA-624   Harmonic Analysis

	L	T	P	C
	3	1	0	4

Basic properties of topological groups, subgroups, quotient group, connected groups.

Discussion of Haar measure without proof on R,T,Z and some simple matrix.

$L^1(G)$ and convolution with special emphasis on L^1 (R), L^1 (T), L^1 (Z).

Approximate identities, Fourier series, Fejer's theorem, the classical kernels, Fejer's, Poisson's and Dirichlet's summability in norm and point wise summability.

Fatou's theorem, the inequalities of Hausdorff and Young, examples of conjugate function series.

The Fourier transform, kernels on R, the Plancherel theorem on R, Plancherel measure on R, T, Z, maximal ideal space of L^1 (R), L^1 (T) and L^1(Z).

Books Recommended:

1. H Helson, "Harmonic Analysis", Addison-Wesley 1983, Hindustan   Pub.Corp.,1994.

2. E Hewitt and K A Ross, "Abstract Harmonic Analysis Vol. I", Springer Verlag, 1993.

3. Y. Katznelson, "An introduction to Harmonic Analysis", John Wiley, 1968.

MA-625   Graph Theory

L T P C
3 1 0 4

Introduction to graphs, simple graph, degree of a graph, regular graphs, complete graphs, bipartite graphs, digraphs, subgraphs, complement of a graph, digraphs and binary relations.

Matrix representations of graphs, adjacency and incidence matrices, walks, paths and circuits, connectedness of a graph.

Planar graph, Euler's formula, Eulerian graphs, Hamiltonian circuits, existence theorems for Eulerian and Hamiltonian graphs, vertex removal, cut vertices and separable graphs, isomorphism.

Trees, spanning trees, breadth-first and depth-first search, cut sets and tie sets.

Applications of graphs in networks, transport problems like shortest path problem and other industrial applications.

Books Recommended:

1. F Harary, "Graph Theory", Narosa Publishing House, New Delhi, 1996.

2. C L Liu, "Elements of Discrete Mathematics", Tata McGraw-Hill Publishing Company New Delhi, 1985.

MA-627   **Descriptive Statistics**

	L	T	P	C
	3	1	0	4

Random variable: discrete random variable, probability mass function, continuous random variable, probability density function, marginal and conditional mass functions. Distribution functions of discrete and continuous random variables (univariate and multivariate).

Expectation of a random variable and its properties, conditional expectation, moments in terms of expectation, moment.

Generating functions, characteristic function, modes of convergence, weak and strong law of large numbers, central limit theorem, probability inequalities (Tchebyshev, Markov).

Correlation and Regression.

Study of some standard distributions- Binomial, Poisson, Negative Binomial, Geometric, Hypergeometric, Normal, Rectangular, Gamma, Beta, Exponential, Laplace.

Bi-variate probability distribution, marginal and conditional distribution, bi-variate normal distribution.

Books Recommended:

1. G. K. Bhattacharya and R. A. Johnson, "Statistical Concepts and Methods", John Wiley, New Delhi, 2002.

2. R. V. Hogg and A. T. Elliot, "Probability and Statistical Inference", Pearson Education, 6th Edition.

3. R. V. Hogg and A. T. Craig, "Introduction to Mathematical Statistical", 6th Edition, Pearson Education, Delhi.

4. V. K. Rohatgi, "Introduction to Probability Theory and Mathematical Statistics", Wiley Eastern, 1976.

5. A. M. Goon, A. K. Gupta and B. Dasgupta, "An Outline of Statistical theory Vol.1", The World Press Pvt. Ltd, 1983.

6. S. C. Gupta and V. K. Kapoor, "Fundamental of Mathematical Statistics",Sultan Chand & Sons, New Delhi,1970.

MA-628   Sampling Distribution and Estimation Theory

$$
\begin{array}{cccc}
\textbf{L} & \textbf{T} & \textbf{P} & \textbf{C} \\
\textbf{3} & \textbf{1} & \textbf{0} & \textbf{4}
\end{array}
$$

Sampling from a distribution: random sample, concept of derived distribution of functions of random variables, concept of a statistic and its sampling distribution. point and interval estimation, concept of bias and standard error of an estimate, standard error of sample mean, sample proportion and sample variance.

Sampling distribution: χ^2-distribution, t-distribution and F-distribution and their properties.

Test of significance: null and alternative hypothesis, errors in sampling (Type I and Type II), critical region, level of significance, Z-test, t-test, χ^2-test, F-test.

Theory of estimation: characteristic of estimators-unbiasedness, consistency, efficiency, sufficiency, most efficient estimator, minimum variance unbiased estimator (MVUE), method of maximum likelihood estimation, most powerful test, uniformly most powerful test, Neyman-Pearson lemma, likelihood ratio test.

Simple non-parametric test for one and two sample problems.

Books Recommended:

1. G. K. Bhattacharya and R. A. Johnson, "Statistical Concepts and Methods", John Wiley, New Delhi, 2002.

2. R. V. Hogg and A. T.Elliot, "Probability and Statistical Inference", Pearson Education, 6th Edition.

3. R. V. Hogg and A. T. Craig, "Introduction to Mathematical Statistical", 6th Edition, Pearson Education, Delhi.

4. V. K. Rohatgi, "Introduction to Probability Theory and Mathematical Statistics", Wiley Eastern, 1976.

5. A. M. Goon, A. K. Gupta and B. Dasgupta, "An Outline of Statistical theory Vol.1", The World Press Pvt. Ltd,1983.

6. S. C. Gupta and V. K. Kapoor, "Fundamental of Mathematical Statistics" Sultan Chand & Sons, New Delhi, 1970.

MA-629   Sampling Techniques

	L	T	P	C
	3	1	0	4

Probability and non-probability sampling, sampling and non-sampling errors, simple random sampling, procedure of selecting a simple random sample, estimation of population parameters and proportion, confidence limits, estimation of sample size.

Stratified Sampling: Principle and advantages of stratification, estimate of population mean and its variance, allocation of sample size in different strata, comparison of stratified random sampling with simple random sampling without stratification, estimation of gain in precision due to stratification, deep stratification.

Systematic random sampling: Estimation of parameters, comparison of systematic with random and stratified random sampling, probability proportion to size sampling and its properties,

Ratio, regression and product estimators, multivariate ratio and regression estimators.

Cluster Sampling: Estimators of mean and their variances for equal and unequal cluster sampling and their relative efficiency.

Multistage and Multiphase Sampling: Two stage sampling with equal and unequal first stage units, double sampling for stratification, optimal allocation, double sampling for difference, ratio and regression estimators,

Successive sampling: Repetitive sampling, sampling on two occasions,

Non-sampling errors: Sources and types of non-sampling error, biases and variable errors, non-sampling bias, incomplete frame and missing units, non-response errors, technique for adjustment, "Politz-Simmon's technique", response error, response bias and response variance, estimation of variance components, extension of other sampling design.

Books Recommended:

1. W. G. Cochran, " Sampling Techniques", John Wiley and Sons, New York, 2007

2. P. V. Sukhatme and B. V. Sukhatme, "Sampling Theory of Surveys with Applications", Iowa State University Press, Ames, Iowa, U.S.A., III revised edition. 1997

3. D. Singh and F. S. Chaudhary, "Theory and Analysis of Sample Survey Designs", New Age International Limited Publishers, New Delhi, 1995.

4. Parimal Mukhopadhyay, "Theory & Methods Of Survey Sampling", Prentice-hall of India Pvt. Ltd. 1998