

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER

Syllabus Choice Based Credit System (CBCS)

M.A. / M.Sc. Mathematics (Semester Scheme) SEMESTER SCHEME

Semester I Dec 2026

Course code	Course title	L	T	P	Credit	Max. marks		Min. pass marks	
						Internal	External	Internal	External
DCC – 01 - Th	Advanced Abstract Algebra	4	0	0	4	30	70	12	28
DCC – 02 - Th	Advanced Complex Analysis	4	0	0	4	30	70	12	28
DCC – 03 - Th	Advanced Tensor Analysis	4	0	0	4	30	70	12	28
DCC – 04 - Th	Advanced Metric Spaces	4	0	0	4	30	70	12	28
DCC – 05 - Th	Advanced Special Functions	4	0	0	4	30	70	12	28
Total Credits = 20						Total Marks = 500			

L: Lecture T: Tutorial P: Practical

DCC: Discipline centric compulsory course.

DETAILED SYLLABUS

DCC – 01- ADVANCED ABSTRACT ALGEBRA

Unit I

Homomorphism and Isomorphism theorems on groups, Conjugate elements. Cayley Theorem, Zassenhaus Lemma, Butterfly theorem (Statement only). Structure of Groups: Conjugate classes and Class equation of a finite group, Cauchy's theorem for finite group (abelian as well as non-abelian). Burnside theorem, Sylow's theorems (Statement and Applications only), Derived subgroup, Normal and subnormal series, The Schreier-Zassenhaus Refinement theorem, Maximal Normal Subgroup, Solvable group and its properties, Nilpotent groups, Composition series, Jordan-Holder Theorem(Statement Only).

Unit II

Euclidean and polynomial rings, Polynomials over rational fields, The Eisenstein criterion, Polynomial rings over commutative ring, unique factorization domain, Chain conditions on rings. Modules: sub modules, Quotient modules, Cyclic modules, Simple module. Semi Simple modules, Schuler's lemma. Free Modules.

Unit III

Field theory: Extension of a field, Splitting field, Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect fields Finite fields Primitive elements, Algebraic closed field, Automorphism of a field, Group of Automorphism of a field, Automorphism of extensions. Galois Theory: Galois Group, Fundamental theorem of Galois theory, Solvability by radicals, Galois Field, Constructible Number.

Books Recommended for Reference :

1. Maclane and Birkoff : Algebra, Macmillan & Co.
2. I.N. Herstein : Topics in Algebra, Wiley Eastern India Ltd.
3. I.S. Luthar and B.S. Passi, : Algebra Vol-I Groups, Vol-II Rings, Narosa Publishing House.
4. Gokhroo et.al. : Advanced Abstract Algebra, Navkar Prakashan, Ajmer
5. Vivek Sahai & Vikas Bist : Algebra, Narosa Publishing, 1999
6. B.S. Vatssa : Modern Algebra, 1999 New Age International Publication.

DCC – 02- ADVANCED COMPLEX ANALYSIS

Unit I

Complex integration, Cauchy's Goursat theorem, Cauchy's integral formula, Higher order derivatives. Morera's theorem. Cauchy's inequality and Liouville's theorem, the fundamental theorem of algebra, Taylor's theorem, Laurent's Theorem Maximum modulus principle, Schwarz lemma.

Unit II

Singularities: Zero, Singularity, Kinds of Singularity, Isolated Singularities, Pole, Meromorphic functions, The Argument Principle. Roche's Theorem, Residues, Cauchy's residue theorem; evaluation of integrals, Branches of many valued functions with reference to $\arg z$, $\log z$, z^n . Inverse Function Theorem, Mittag Leffler's theorem, Fundamental theorem of algebra, Jordan's lemma.

Unit III

Riemann mapping theorem, Direct Analytic Continuation, Power series method of analytic continuation, Schwartz's Reflection Principle, Gamma function and its properties, Riemann-Zeta Function, Riemann's functional equations.

Books Recommended for Reference :

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| 1.R.V. Churchill | : Complex Analysis, TMH (International) |
| 2.S. Ponnusamy | : Foundation of Complex Analysis, Narosa Publishing House. |
| 3.Shanti Narain | : Complex Analysis, S.Chand & Co., New Delhi |
| 4.Gokhroo et.al | : Complex Analysis, Navkar Prakashan, Ajmer |
| 5.K.P. Gupta | : Complex Analysis, Krishana Prakashan Mandir, Meerut. |
| 6.B. Choudhary | : Complex Analysis, Wiley Eastern Ltd. New Delhi. |

DCC – 03- ADVANCED TENSOR ANALYSIS

Unit I

Transformation of Coordinates, Covariant, Contravariant, mixed tensor, Invariants, Addition, subtraction and multiplication of tensors. Contractions of tensors, Quotient Law of tensors. Metric tensor, Riemannian space, Reciprocal metric tensor, Fundamental Tensors, Length of Curve, Null curve, Associated tensors.

Unit II

Christoffel symbols, Transformation of Christoffel symbols, Covariant Differentiation of tensors, Laws of covariant differentiation, Ricci's theorem, Tensorial form of divergence theorem, Tensorial form of Stoke's theorem, Fundamental theorem of Riemannian Geometry, Curvature of a curve, Geodesics, Null Geodesics, Geodesics Co-ordinates Parallelism, generalized covariant derivatives.

Unit III

Reimann Christoffel tensor, Ricci tensor, Covariant curvature tensor, Einstein Space, Bianchi Identity, Einstein Tensor, Bianchi Reimann curvature, Flat space, space of constant curvature, Schur's theorem, Geodesic deviation, Lie-Derivative, Killing equation, Integrability condition of Killing equation, Decomposition of Riemann Curvature Tensor, Conformal Invariance, Classification of Gravitational Fields, Curvature Tensors Involving Reimann Tensor.

Books Recommended for Reference :

1. Berry Spain : Tensor Calculus
2. Raj Bali : Tensor Calculus, Navkar Prakashan, Ajmer
3. Goodbody, A M : Cartesian Tensor
4. Bansal J.L. : Tensor Calculus, Jaipur Publishing House, Jaipur.

DCC – 04- ADVANCED METRIC SPACES

Unit I

Metric Spaces : Definition, Euclidean spaces, inequalities, bounded and unbounded metric space, Basic concept of spheres, open sets, equivalent metrics, closed sets, neighborhoods, accumulation points, adherent points, closure interior exterior, frontier and boundary of a set, bases, subspace of a metric spaces, product spaces.

Unit II

Complete Metric Spaces : Sequence and subsequences in metric spaces Cauchy sequences, complete metric space, Baire's category theorem, completeness and contracting mappings, complete metric space, completion of a metric space. N Connectedness; Separated sets, connected and disconnected sets, connectedness on the real line, components, totally disconnected spaces, locally connected spaces.

Unit III

Compactness : Hausdorff axiom, compact spaces, Lindelof spaces, locally compact spaces, product of two compact spaces, Preliminary limits and continuity, homomorphism, continuity and connectedness, continuity and compactness projection mappings, connectedness of the product of two spaces, uniform continuity, extension theorems.

Books Recommended for Reference :

1. Micheal O'Searcoid : Metric spaces, Springer
2. Nahar, T.S. : Advanced Metric spaces, Navkar Prakashan, Ajmer
3. R.B.Ash : Real Variables with Basic Metric space topology, Dover
4. J.N. Sharma : Metric Spaces, Krishna Prakashan Mandir, Meerut.

DCC – 05- ADVANCED SPECIAL FUNCTIONS

Unit I

Gamma Function : Definition of Gamma and Beta Function, Factorial, Properties of Gamma Function, Multiplication theorem, Legendre's Duplication Formula. Hypergeometric Functions: Series solution of Gauss hypergeometric equation, Gauss hypergeometric function and its properties, integral representation, linear and quadratic transformation formulas, contiguous function relations, differentiation formulae, linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its properties, integral representation, Kummer's first transformation. _

Unit II

Bessel Function : Generating function for $J_n(x)$, alternative forms of generating functions, trigonometric expansions involving Bessel functions, Bessel's differential equation and its solutions, recurrence relations, Bessel's integrals, modified Bessel function, orthogonality of Bessel functions, some integral involving Bessel functions. Hermite Polynomial : Definition of Hermite polynomials $H_n(x)$, pure recurrence relations, differential recurrence relations, Rodrigue's formula, other generating functions, orthogonality, expansion of polynomials, more generating functions, hypergeometric representations, integral representation of Hermite polynomial, differential equation and its solution.

Unit III

Legendre Polynomial : Generating function, Recurrence relation, successive values of Legendre polynomials, Beltrami's result, Christoffel's expansion, Christoffel's summation formula, various forms of $P_n(x)$ Rodrigue's formula, hypergeometric form, Laplace first and second integral of $P_n(x)$ and related problems, Legendre's differential equation and its general solution, orthogonality properties, expansion involving Legendre polynomial, Legendre function of second kind and its properties. Laguerre Polynomials: The Laguerre Polynomials $L_n(x)$, generalized Laguerre polynomial, generating functions, pure recurrence relations, differential recurrence relation, Rodrigue's formula, orthogonal, expansion of polynomials, special properties, other generating functions integral relations.

Books Recommended for Reference :

1. Rainville E.D. : Special Functions Chapter :1,6,8,11 & 12
2. Slater L.J : Confluent Hypergeometric Functions, Cambridge University Press,1966
3. L.J. Slater : Generalized Hypergeometric Functions, Cambridge University Press, 1966
4. Gokhroo et.al : Special Functions, Navkar Prakashan, Ajmer
5. Saran, et. al. : Special Functions, Pragati Prakashan, Meerut

Semester II June 2027

Course code	Course title	L	T	P	Credit	Max. marks		Min. pass marks	
						Internal	External	Internal	External
DCC – 06 - Th	Advanced Linear Algebra	4	0	0	4	30	70	12	28
DCC – 07- Th	Advanced Measure Theory	4	0	0	4	30	70	12	28
DCC – 08 - Th	Advanced Topology	4	0	0	4	30	70	12	28
DCC – 09 - Th	Advanced Integral Transforms	4	0	0	4	30	70	12	28
DSE – 01 A - Th	Advanced Differential Geometry	4	0	0	4	30	70	12	28
DSE – 01 B - Th	Advanced Mathematical Modeling	4	0	0	4	30	70	12	28
Total Credits = 20						Total Marks = 500			

L: Lecture **T:** Tutorial **P:** Practical

DCC: Discipline Centric Compulsory Course.

DSE: Discipline Specific Elective

DETAILED SYLLABUS

DCC – 06- ADVANCED LINEAR ALGEBRA

UNIT-I

Vector spaces: Definition and examples of a vector spaces, subspaces, linear sum and direct sum of subspaces, linear combination of vectors, linear span, linear dependence independence and their basic properties, basis, finite dimensional vector spaces, existing theorem for basis, Vector space of a linear transformation, Matrix representation of a linear transformation, the algebra of linear transformation, Sylvester's law of nullity.

UNIT-II

Change of Basis, Similarity, Eigen value and eigenvectors for a linear operator, Cayley-Hamilton theorem, Diagonalization of Matrices, Adjoint of a linear transformation and its properties, Bilinear, Quadratic and Hermitian forms, Inner product spaces, Cauchy- Schwarz inequality.

UNIT-III

Orthogonal vectors, orthogonal complements, ortho-normal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process. normal and self-adjoint matrices and transformation, unitary matrices and transformations, Principal axis theorem.

Books Recommended for Reference :

1. Hofman and Kunz. : Linear Algebra, Prentice Hall of India.
2. K.B. Datta : Matrix and Linear Algebra,
Prentice Hall of India Pvt. Ltd., New Delhi.
3. Gokhroo et.al : Advanced Linear Algebra, Navkar Prakashan, Ajmer
4. P.M. Cohn : Algebra vol I,II & III, John Wiley & Sons, 1982-89, 91
5. Gopal Krishanan, N.S. (II ed.) : University Algebra, New Age International Publication

DCC – 07- ADVANCED MEASURE THEORY

UNIT-I

Countable and uncountable sets. Outer measure of a set and its properties. Measurable sets. Lebesgue measure, a non-measurable set. Measurable functions and their properties.

UNIT-II

Convergence of sequence of measurable functions. Concept of almost everywhere. Littlewood's three principles. Lebesgue integral of measurable functions, Lebesgue theorem on the passage to the limit under the integral sign.

UNIT-III

Summable functions, the space of square summable functions, Convergence in Mean, Cauchy sequence in L_2 Space, Weak convergence, Orthonormal systems.

Books Recommended for Reference :

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| 1.T.M. Apostol : | Mathematical Analysis, Narosa Publishing House, New Delhi (1985) |
| 2.Gabriel Klambauer : | Mathematical Analysis, Mared Dekker Inc., New York (1975) |
| 3.T.S. Nahar : | Measure Theory, Navkar Prakashan, Ajmer. |
| 4.P.K. Jain and V.P.: | Lebesgue Measure and Integration, New Age
International Pub. Ltd., New Delhi (Reprint 2000) |
| 5.Indra Kumar Rana : | An Introduction to Measure and Integration,
Narosa Publishing House, New Delhi (1997) |

DCC – 08- ADVANCED TOPOLOGY

Unit I

Topological spaces : Topology, T-open sets, weaker and stronger topology, Indiscrete and discrete topology, co-finite topology, usual topology, open sets, closed sets, neighbourhood, closure, interior, limit point, relative topology, upper limit topology, intersection of topological spaces, Continuity, Homomorphism, Open and Closed maps.

Unit II

Base, sub-base and countability : Base, sub-base, local base, first countable, second countable, theorems, hereditary property, theorems related to metric space, sequence in a topological space. Separation axioms: T₀, T₁, T₂, spaces, normal spaces, Hausdorff space, regular spaces, T₃, T₄-spaces, completely regular spaces, Tychonoff space.

Unit III

Compactness : Cover, open cover, finite sub-cover reducible, compact sets, finite intersection property, Heine-Borel, Bolzano Weierstrass property Connectedness : Separated sets, disconnectedness, totally disconnected, maximal connected set. Product Spaces : Product topology, projection maps, problems related to product invariant, topology for the cartesian product of arbitrary collection, Tychonoff topology. Nets and convergence : Binary relation, directed set, residual subset, cofinite subset, net sequence convergence of a set, cluster point, subnet, isotones map. Filter the ultra filters : Filter, cofinite filter, Nbd filter, filter base, ultrafilters.

Books Recommended for Reference :

1. S.Lipsechutz : General topology. The any problem, MCgraw Hill Co. (ch.V,VI,X,Xi)
2. Gokhroo et. al. : Topology, Navkar Prakashan, AJMER
3. G.F.Summons : Introduction of Topology and Modern Analysis, MCgraw Hill Co.

DCC – 09- ADVANCED INTEGRAL TRANSFORMS

Unit I

Laplace Transforms : Definition, Laplace Transform of some standard elementary functions, simple properties, Laplace transform of the derivatives, Laplace Transform of some standard special functions. Inverse Laplace Transforms : Inverse Laplace transform and its properties, Evaluation of inverse Laplace transform, Inverse Laplace transform of derivatives, Convolution, Properties of convolution, convolution theorem, complex inversion formula. Fourier Transform : Fourier Sine and Cosine transform, Inverse Fourier Transform, convolution Theorem, Parseval's identity, Fourier transform of derivatives.

Unit II

Application of Laplace Transform for the solution of ordinary differential equations with constant coefficients and with variable coefficient, Simultaneous ordinary differential equations. Solution of Partial differential equations, BVP, Heat Conduction Equation, Wave Equation. Application of Fourier Transform in the solution of boundary value problems. Application to the solution of partial differential equations.

Unit III

Hankel Transform : Definition and Elementary properties, Inversion formula for Hankel transform, Hankel transform of first and second derivatives, Parseval's theorem. Mellin Transform : Definition and Elementary properties, Mellin transform of derivatives and Integrals, Inversion formula for Mellin transform, convolution theorem for Mellin transform.

Books Recommended for Reference :

1. Sneddon.I.N : The use of integral Transforms, Mcgraw Hill Co., 1966
2. Spegal M.R : Theory and problems of Laplace transform, Schaum Series,TMH
3. Gokhroo et. al. : Integral Transforms, Navkar Prakashan, Ajmer.
4. Vasishta et. al. : Integral Transforms, Krishna Prakashan Mandir, Meerut
5. M.D. Raisingania : Integral Transforms, Kedar Nath Ram Nath, Meerut.

DSE – 01 A - ADVANCED DIFFERENTIAL GEOMETRY

Unit I

Curves in Space : Curves in space (R^3) : Space curves, path, arc length, tangent line, contact of a curve and surface inflexional tangent, the osculating plane, tangent at any point of a surface $f(x,y,z) = 0$, Normal plane, principal normal plane and binormal curvature, torsion and skew curvature, Serret-Frenet formulae, Helices, Fundamentals theorems for space curves, circle of curvature, osculating sphere. Surfaces in General : Tangent, Tangent plane, inflexional tangent, the osculating plane, tangent at any point of a surface $f(x, y, z) = 0$. Singular point, Indicatrix.

Unit II

Envelopes and Ruled Surfaces : Envelope, Edge of regression, Ruled surfaces, Developable surfaces. Curves on Surfaces : Metric of a space, First, Second and Third Fundamental Forms, Fundamental magnitudes of some important surfaces, orthogonal trajectories. Curvature of Surfaces and Lines of Curvature : Normal curvature, Meunier's theorem, Principal directions, Principal Curvatures Lines of curvature, Joachi msthal theorem, Third fundamental form.

Unit III

Conjugate Directions and Asymptotic Lines : Conjugate directions Asymptotic lines, Curvature and Torsion of Asymptotic lines, Beltrami and Enneper theorem, Gauss Characteristic equations, Mainardi - Codazzi equations, Bonnet theorem. Geodesics : Geodesics Differential equation of a geodesic single differential equation of a geodesic Geodesics on a surface of revolution, Geodesic curvature and Torsion, Gauss-Bonnet theorem.

Books Recommended for Reference :

1. C.E.Weatherburn : Differential Geometry
2. H.C.Sinha : Differential Geometry
3. Raj Bali : Differential Geometry, Navkar Prakashan, Ajmer.
4. Bell, R.J.T., : Coordinate Geometry of three dimensions.

Unit I

Introduction : Implications of Mathematical Modeling being an Art, Trade offs needed in designing Courses, Groups and ideas on Mathematical Modeling, Training of General Mathematical Modelers. Difference Equations and their Applications in Mathematical Models. Formulation, Definition and Properties of Difference Equations, Uniqueness and Existence Theorem for the solution of a Difference Equation, Linear homogeneous difference equations with constant coefficients, Methods for solution of homogeneous linear difference equations, Linear Homogeneous Difference Equation with Variable Coefficients, Non-Homogeneous Linear Difference Equation with constant coefficients, Non-Homogeneous Linear Difference Equation with Variable Coefficients, Solution of some special Types of Difference Equations , Solution of Homogeneous Difference Equation of Degree Two, Solution of simultaneous difference equations, Method of Generating functions , Matrix method to solve simultaneous difference equations, Differential Difference Equations, Application of difference equations in mathematical modeling, Difference methods for the model having parabolic in nature, Difference methods for the model having hyperbolic in nature, Alternating Direction Implicit (ADI) Methods, Difference methods for the model having elliptic in nature, Difference methods for linear boundary value problems, Dirichlet problem for Laplacian.

Unit II

Mathematical Modeling through Calculus of Variations : Some Basic Problems of Calculus of Variations, Functionals, The Simplest Variational Problems, Extremal or Solutions of Euler's Equation, Geodesics, Isoperimetric Problems, Variational Notation , Actual Path and Varied Path, Hamilton's "Canonocal Equation of Motion" Or Hamilton's Equation of Motion, Hamiltons' Principle, Principle of Least Action, Lagrangian of a System , Lagrange's Equation, Deduction of Lagrange's Equation from Hamiltons' Principle, Vibration of a Flexible Stretched String, Transverse Bending oscillations of a Straight Uniform Beam, Mathematical Modeling in Physical Sciences : Shot Putt Analysis, Electric Circuits, Electrical Networks, Chemical Kinetics, Rocket Flight, Cooling and Heating of Water, Mathematical Modeling in Engineering Sciences : Spring Mass System (I), Spring Mass System (II), Technological Innovations Model.

Unit III

Mathematical Modeling in Biological Sciences : Diabetes, Diabetes Testing, Artificial Kidney Machine, Stimulus Model, Single species population Model : Exponential Growth Model, Limitation, Extension of the Logistic Model, Two species Population Model, EPIDEMICS, Simple Epidemic Model, Formulation of the Model, Mathematical Modeling in Social Sciences : Population Model, A Fram work for Modeling, Inhibited Growth Models, Fish Polulation Model, Economic Growth Model, Consumer Behaviour Model, Epidemics Model, Model of Traffic Flow Across the Road, Shortest Stopping Distances, Maximising Traffic Flow through tunnels.

Books Recommended for Reference :

1. Kapur J.N. : Mathematical Modeling, New Age Publication, New Delhi.
2. Saxena V.P. : Mathematical Models in Biology
3. Mauriya R.P., et.al. : Mathematical Modeling, Navkar Prakashan, Ajmer.

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER

Syllabus Choice Based Credit System (CBCS)

M.A. / M.Sc. Mathematics (Semester Scheme) SEMESTER SCHEME

Semester III June, 2027

Course code	Course title	L	T	P	Credit	Max. marks		Min. pass marks	
						Internal	External	Internal	External
DCC – 10 - Th	Advanced Functional Analysis-I	4	0	0	4	30	70	12	28
DCC – 11 - Th	Advanced Differential Equations and Calculus of Variations	4	0	0	4	30	70	12	28
DCC – 12- - Th	Advanced Mathematical Statistics-I	4	0	0	4	30	70	12	28
DSE – 02- A - Th	Advanced Continuum Mechanics-I	4	0	0	4	30	70	12	28
DSE – 02- B - Th	Advanced Operations Research - I	4	0	0	4	30	70	12	28
DSE – 02- C - Th	Advanced Discrete Mathematics-I	4	0	0	4	30	70	12	28
DSE – 02- D - Th	Special and General Theory of Relativity	4	0	0	4	30	70	12	28
DSE – 03- A - Th	Advanced Numerical Methods - I	4	0	0	4	30	70	12	28
DSE – 03- B - Th	Hydrostatics	4	0	0	4	30	70	12	28
DSE – 03- C - Th	Dynamics of a Particle	4	0	0	4	30	70	12	28
DSE – 03- D - Th	Generalized Hypergeometric Functions - I	4	0	0	4	30	70	12	28
Total Credits = 20 Total Mark = 500									

L: Lecture, T: Tutorial, P: Practical

DCC: Discipline Centric Compulsory Course.

DSE: Discipline Specific Elective

Select any one (total two) Discipline specific Elective (DSE) Courses from each DSE – 02 and 03 group of the above in III semester.

DETAILED SYLLABUS

DCC – 10- ADVANCED FUNCTIONAL ANALYSIS - I

UNIT-I

Normed linear spaces, quotient space of normed linear spaces and its completeness, Banach spaces and examples, bounded linear transformations, normed linear space of bounded linear transformations, equivalent norms, basic properties of finite dimensional normed linear spaces and compactness, Reisz lemma, multilinear mapping, open mapping theorem. closed graph theorem, uniform boundedness theorem.

UNIT – II

Continuous linear functional, Hahn-Banach theorem and its consequences, embedding and reflexivity of normed spaces, dual spaces with examples, inner product spaces, Hilbert space and its properties.

UNIT-III

Orthogonality and functionals in Hilbert Spaces, Pythagorean theorem, projection theorem, orthonormal sets, Bessel's inequality, complete orthonormal sets, parseval's identity, structure of a Hilbert space, Riesz representation theorem, reflexivity of Hilbert spaces.

Books Recommended for Reference :

1. GG Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, New York.
2. T.S. Nahar : Advanced Functional Analysis, Navkar Prakashan, Ajmer.
3. L. A. Luesternik and L.J Sobolev : Elements of Functional Analysis, Hindustan Pub. Co.
4. A.E. Taylor : Introduction to Functional Analysis, John Wiley and Sons.

DCC – 11- ADVANCED DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS

UNIT-I

Countable sets. Outer measure of a set and its properties. Measurable sets. Lebesgue measure, a non-measurable set. Measurable functions and their properties.

UNIT-II

Convergence of sequence of measurable functions. Concept of almost everywhere. Littlewood's three principles. Lebesgue integral of measurable functions, Lebesgue theorem on the passage to the limit under the integral sign.

UNIT-III

Functionals, Variation of a functional and its properties, Variational problems with fixed boundaries, Euler's equation, Extremals, Functional dependent on several unknown functions and their first order derivatives. Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form. Applications of Calculus of variations.

Books Recommended for Reference :

1. Forsyth, A.R. : Calculus of Variations
2. Gokhroo, et.al. : Advanced Calculus of Variations, Navkar Prakashan, Ajmer.
3. Akhiezer, NI : The calculus of variation Blaisdell publishing Co., New Delhi
4. Gupta, A.S. : Calculus of Variations with applications.
5. Bliss, G.A., : Calculus of variations. The university of Chicago Press Chicago
Cambridge University Press, New York
6. Weinstock, RP : Calculus of variations. McGraw Hill Book Co., Inc, New York.

DCC – 12- Advanced Mathematical Statistics-I

UNIT-I

Sample spaces, Combination of events. Statistical independence, Conditional probability, Bays theorem, Repeated trials. Random Variable, Distribution function, Probability, Probability function, Density function.

UNIT-II

Mathematical expectation, Generating function (mfg and pgf) continuous probability distribution, characteristic function, Fourier's Inversion, Chebyshev and Kolmogorov inequality. weak and Strong law of large numbers, Normal, Hypergeometric, Rectangular, Negative, Binomial, Beta, Gamma and Cauchy's distribution.

UNIT-III

Methods of least square and curve fitting, correlation and regression coefficient. Index number, Introduction, Price-relatives, Quantity relatives, Value relatives, Link and Chain relatives, Aggregate methods, Fisher's Ideal Index, Change of the base period of the index numbers.

Books Recommended for Reference :

1. Kapur and Saxena : Mathematical Theory of Statistics.
2. Gokhroo, et.al. : Advanced Mathematical Statistics, Navkar Prakashan, Ajmer.
3. Weatherburn : A First Course in Mathematical Statistics.
4. M.G. Kendall : The Advanced Theory of Statistics.
5. Uspensky : Introduction of Mathematical Probability.

DCE – 02 A Advanced Continuum Mechanics – I

UNIT-I

Cartesian Tensors, index notations and transformation, laws of Cartesian tensors, additions, subtraction and multiplication of Cartesian tensor, gradient of a scalar function, divergence of a vector function and curl of a vector function using the index notation, the identity Stokes Gauss and Green's theorems.

UNIT-II

The continuum approach classification of continuous media, body forces and surface forces. components of stress tensor, forces and moment equation of equilibrium, the stress quadric, principle stresses and principle axes, stress invariants and the stress deviator tensor, maximum shearing stress.

UNIT-III

Lagrangian and Eulerian description of deformation of flow, the comoving derivative, velocity and acceleration, the continuity equation, strain tensors, the linear rotation tensor and rotation vector, analysis of rotation displacement, geometrical meaning of the components of the linear strain tensor, principal axis theory for the linear strain tensor, properties of linear strain tensors.

Books Recommended for Reference :

1. D. Frederic and T.S. Chang: Continuum Mechanics, Ally and Bacon. Inc. Boston
2. Mase. G.E: Continuum Mechanics (Schaum series)
3. Sommerfield A: Mechanics Deformable bodies.
4. Morton E. Gurtin: An Introduction to Continuum Mechanics (Academic Press)
5. Sharma, K.D.: Continuum Mechanics, Navkar Prakashan, AJMER.

DCE – 02 B Advanced Operations Research – I

UNIT-I

Linear programming: Simplex method, theory of the simplex method, Big-M Method, Two Phase Method, Degeneracy in LPP, Redundancy and inconsistency, duality, Transportation and Assignment Problems.

UNIT-II

Revised Simplex method, sensitivity analysis in linear programming, integer programming models, integer programming models with binary variables, the Branch-and-Bound method for solving integer programming problems.

UNIT-III

Game theory: Two person, zero-sum games, games with mixed strategies, graphical solution, solution by linear programming.

Dynamic Programming: Introduction to dynamic programming problems, deterministic dynamic programming.

Books Recommended for Reference:

- 1.G. Hadley: Linear Programming
- 2.Gokharoo et al : Advanced Operations Research, Navkar Prakashan, Ajmer.
3. T.L. Saaty : Mathematical Methods of Operational Research
- 4.Sadieni, Friedman and Yaspan : Operations Research
5. S. Vajda : Mathematical Programming
6. Kanti Swarup, P.K. Gupta & D. S. Hira: Operations Research-An Introduction

DCE – 02 C Advanced Discrete Mathematics - I

UNIT-I

Number Systems and Codes : Natural numbers, Integers, Rational numbers, Real numbers, Complex numbers, Arithmetic modulo a positive integer (Binary, Octal, Decimal and Hexadecimal Number systems), Radix r representation of integers. Representing negative and Rational numbers, Floating point notation, Binary Arithmetic, 2's complement arithmetic, Conversions of numbers from one of Binary / Octal / Decimal / Hexadecimal number system to other Number systems. **Sets :** Sets, Subsets, Equal Sets Universal Sets, Finite and Infinite Sets, Operation on Sets, Union, Intersection and Complements of Sets, Cartesian Product, Cardinality of Set, Simple Applications.

UNIT-II

Relations and Functions : Properties of Relations, Equivalence Relation, **Partial Order Relation Function :** Domain and Range, Onto, Into and One to One Functions, Composite and Inverse Functions, Hashing functions, Recursive function. Partial Order Relations and **Lattices :** Partial Order Sets, Representation of POSETS using Hasse diagram, Chains, Maximal and Minimal Point, Glb, lub. **Combinatorics :** The Fundamental principle of counting , Permutations, Combinations, Pigeonhole Principle, Principle of Mathematical Induction, Principle of Inclusion and Exclusion.

UNIT-III

Group Theory : Groupoid, Monoid, Group, Definitions and Properties, Coset and Subgroup, Normal subgroup, Homomorphism of groups, Cyclic Group, Permutation Group, Dihedral group. Rings, Integral Domains, Fields etc. Lattices : Lattices, Principle of Duality, Bounded, Distributed and Complemented Lattices. Formal Logic and Propositional Calculus : Formal Logic : Statement, Symbolic Representation and Tautologies, Quantifiers, Predicate and validity, Normal form. Propositional Calculus, Predicate Logic, Logic Programming and Proof of correctness.

Books Recommended for Reference:

1. Seymour Lipschutz and Marc Lars Lipson , The Theory and Problems of Discrete Mathematics, Third Edition, McGraw-Hill Book Co. New –York.
2. J. E. Hopcroft and J.D. Ullman, Introduction to Automata Theory Languages & Computation, Narosa Publishing House, Delhi, 2007.
3. Gokharoo et al : Advanced Discrete Mathematics, Navkar Prakashan, Ajmer.
4. S.K. Sarkar, A Text book of Discrete Mathematics, S Chand and Company Ltd., 2006.
5. C. L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book Co.

DCE – 02 D Special and General Theory of Relativity

UNIT-I

Inertial frame, Galilean Transformations, Michelson and Morely Experiment, Relative character of space and time, Principle of relativity and its postulates, Derivation of special Lorentz's transformation equations. Lorentz Fitzgerald Contraction formula, Simultaneity, time dilation, Proper time, Composition of parallel velocities, Relativistic formulae for composition of Accelerations Relativistic Aberration.

UNIT-II

Variation of mass with velocity, Equivalence of mass and energy, Transformation formulas for mass, momentum, Energy, Force and density. Minkowski space, Space and time like intervals, Null Cone, World point and World line, Proper time, Relativistic Lagrangian & Hamiltonian. Minkowski's equation of Motion. Energy momentum four vectors. Relativity and causality. Clock Paradox. General Lorentz transformation.

UNIT-III

Hamiltonian principle, Energy - Momentum tensor and its expression for perfect fluid, Principle of Covariance, Principle of equivalence, Condition for flat space time, Einstein's law of gravitational for empty space and material world, Schwarz child exterior and interior solution for gravitational field.

Books Recommended for Reference:

1. Tolman R.C. : Relativity, Thermodynamics and Cosmology, Oxford University Press.
2. Synge J.L. : Relativity the Special and General, North Holland Publishing company, Amsterdam.
3. Eddington A.S. : The Mathematical Theory of Relativity, Cambridge.
4. Satya Parkash : Relativistic Mechanics
5. Goyal et al : Theory of Relativity, Pragati Prakashan Meerut.
6. Rajbali et al : Theory of Relativity, Jaipur Publishing House, Jaipur.

DCE – 03 A Advanced Numerical Methods - I

UNIT-I

Computer Arithmetic : Floating point representation of numbers, arithmetic operations with normalized floating point numbers and their consequences. Error in number representation-pitfalls in computing, Errors in numerical calculations and remainder terms in various interpolation and quadrature formulae. **Iterative Methods:** Simple iteration theory of iteration, acceleration of convergence, methods for multiple and complex roots, Newton-Raphson method for simultaneous equations, convergence of iteration process in the case of several unknown.

UNIT-II

Solution of polynomial equations, polynomial evaluation, real and complex roots, synthetic division, the Birge-Vieta, Baristow and Graffe's root squaring methods, system of simultaneous equation (Linear) –direct methods –Methods of determination

UNIT-III

Gauss elimination, Gauss Jordan, Cholesky, Partition methods of successive, approximate – conjugate Gradient, Gauss and Jacobi iteration, Gauss Seidal iteration & Relaxation methods. Eigen value problem, basic properties of eigen values and eigen vectors, power methods for finding all eigen pairs of a matrix, complex eigen values.

Books Recommended for Reference :

1. Jain, Iyengar & Jain: Numerical Analysis
2. Jain M.K.: Numerical Solution of differential equations
3. Gokhroo et. al.: Advanced Numerical Methods, Navkar Prakashan, AJMER

DCE – 03 B Hydrostatics

UNIT-I

Fluid and Fluid Pressure Fluid Pressure, Pascal's Law, Bramah's Press, Density, Specific Gravity etc., Fluid Pressure Under Gravity : Pressure at all points in a horizontal plane, pressure at some depth, surface of equal densities, free surface, surface of separation of two liquids, Fluid Pressure on Plane Surfaces Fluid Pressure on Plane Surfaces : Whole pressure, whole pressure on plane surfaces, Whole pressure on a plane surface below the layers of different liquids, Whole pressure on a horizontal base.

UNIT-II

Centre of Pressure (CP) : Coordinates of Centre of Pressure, C.P. of a parallelogram with one side in the surface of the liquid., C.P. of a triangular lamina immersed in a liquid with its vertex in the free surface and the base horizontal, C.P. of a triangular area immersed in liquid with one side in the free surface, the centre of pressure of a vertical circular area of radius a wholly immersed with its centre at a depth h , Centre of Pressure of a Compound area, Centre of Pressure of the Remainder, Effect of further immersion, C.P. by Integration

UNIT-III

Fluid Thrust on Curved Surfaces : *Resultant vertical and horizontal thrust, Archimedes Principle* Floating Bodies : Principle of Floatation, Conditions of equilibrium of floating body in one or more liquids, Apparent weight, True weight of the body Stability of Floating bodies : Stable, unstable and neutral equilibrium, kinds of displacement, meta centre.

Books Recommended for Reference:

1. M.Ray : A Text Book of Hydrostatics, S. Chand & Co., New Delhi.
2. Gokharoo et al : Hydrostatics, Navkar Prakashan, Ajmer.
3. Hari Kishan : Hydrostatics, Atlantic Publishers.
4. D.S. Molah : Hydrostatics, Books & Allied Pvt. Ltd.
5. B.D. Gupts et al : Hydro-statics, Pragati Prakashan, Meerut.

DCE – 03 C Dynamics of a Particle

UNIT-I

Velocities and acceleration along radial and transverse, tangential and normal directions, Simple harmonic motion, Rectilinear motion under various laws, Hook's law, related problems on horizontal and vertical elastic strings, Constrained motion, Circular and Cycloidal motion.

UNIT-II

Motion in Resisting medium; motion of a projectile in a resisting medium in which resistance varies as velocity, square of velocity, motion on a smooth curve under resistance, motion on a revolving curve. Central forces, Central orbits, aerial velocity and linear velocity in central orbits, Laws of force and related problems, Apses and apsidal distance, problems related to the path of the particle, Differential equation of the path under radial and transverse accelerations.

UNIT-III

The inverse square law and related problems, Kepler's law of planetary motion, time of description of an arc of an elliptic, parabolic, hyperbolic orbit, Euler's theorem, Work, Power, Energy and Impulse.

Books Recommended for Reference:

1. S.L.Loney : Dynamics
2. A.S.Ramsay : Dynamics
3. Gokhroo et al : Dynamics, Navkar Prakashan, Ajmer.
4. N. P. Bali : Dynamics, Laxmi Publications.

DCE – 03 D Generalized Hypergeometric Functions – I

UNIT-I

Generalized hypergeometric function ${}_pF_q(a,b;c;z)$, characterization, integral representation, contiguous function relations, hypergeometric differential equation and its solutions, ${}_pF_q(a,b;c;z)$ as function of its parameters, elementary series manipulations, simple transformation and summations, confluent hypergeometric functions and other properties.

UNIT-II

Convergence conditions for ' ${}_pF_q$ ' differential equation and its solution, Watson's, Dixon's, Whipple's and Saalschütz theorems for the series ${}_3F_2$ with unit argument, fundamental theorem due to Thomae's, Ramanujan's theorem, some special generalized hypergeometric functions.

UNIT-III

Contour integral representation for ${}_pF_q$, Euler's type integrals involving ${}_pF_q$, special cases, product formulae due to Ramanujan, Preece and Bailey, **Mac Roberts E-function** : Definition and convergence conditions, recurrence relations and integrals involving E functions.

Books Recommended for Reference:

1. Rainville, E.D : Special Functions: The Macmillan co.,
2. Mathai et al : Generalized Hypergeometric function with Application in Statistics and physical Sciences:, Springer Verlag
3. Gokhroo et al : Generalized Hypergeometric Functions, Navkar Prakashan, Ajmer.
4. Saran et al : Special Functions, Pragati Prakashan,
5. Yudell L Luke : The Special Function and their approximation: Academic Press.

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER**Syllabus Choice Based Credit System (CBCS)****M.A. / M.Sc. Mathematics (Semester Scheme) SEMESTER SCHEME****Semester IV Dec., 2027**

Course code	Course title	L	T	P	Credit	Max. marks		Min. pass marks	
						Internal	External	Internal	External
DCC – 13 - Th	Advanced Functional Analysis-II	4	0	0	4	30	70	12	28
DCC – 14 - Th	Advanced Linear Integral Equations	4	0	0	4	30	70	12	28
DCC – 15 - Th	Advanced Mathematical Statistics-II	4	0	0	4	30	70	12	28
DSE – 04- A - Th	Advanced Continuum Mechanics-II	4	0	0	4	30	70	12	28
DSE – 04- B - Th	Advanced Operations Research - II	4	0	0	4	30	70	12	28
DSE – 04- C - Th	Advanced Discrete Mathematics-II	4	0	0	4	30	70	12	28
DSE – 04- D - Th	Relativistic Cosmology	4	0	0	4	30	70	12	28
DSE – 05- A - Th	Advanced Numerical Methods - II	4	0	0	4	30	70	12	28
DSE – 05- B - Th	Fluid Dynamics	4	0	0	4	30	70	12	28
DSE – 05- C - Th	Dynamics of Rigid Bodies	4	0	0	4	30	70	12	28
DSE – 05- D - Th	Generalized Hypergeometric Functions - II	4	0	0	4	30	70	12	28
Total Credits = 20 Total Mark = 500									

L: Lecture, T: Tutorial, P: Practical**DCC: Discipline Centric Compulsory Course.****DSE: Discipline Specific Elective**

Select any one (total two) Discipline specific Elective (DSE) Courses from each DSE – 02 and 03 group of the above in IV semester.

DETAILED SYLLABUS

DCC – 13- ADVANCED FUNCTIONAL ANALYSIS - II

UNIT-I

Adjoint of an operator on a Hilbert space, self-adjoint, positive, normal and unitary operators and their properties, projection on a Hilbert space, invariance, reducibility. orthogonal projections.

UNIT – II

Derivatives of a continuous map from an open subset of Banach space to a Banach space, rules of derivation, derivative of a composite, directional derivative, mean value theorem and its applications.

UNIT-III

Partial derivatives and Jacobian matrix, continuously differentiable maps, higher derivatives, Taylor's formula, inverse function theorem, implicit function theorem, step function, regulated function, primitives and integrals, differentiation under the integral sign, Riemann integral of function of real variable with values in normed linear space.

Books Recommended for Reference :

1. GG Simmons : Introduction to Topology and Modern Analysis, McGraw Hill, New York.
2. T.S. Nahar : Advanced Functional Analysis, Navkar Prakashan, Ajmer.
3. L. A. Luesternik et al : Elements of Functional Analysis, Hindustan Pub. Co.
4. A.E. Taylor : Introduction to Functional Analysis, John Wiley and Sons.

DCC – 14- Advanced Linear Integral Equations

UNIT-I

Linear integral equations : Definition and classification. Conversion of initial and boundary value problems to an integral equation. Eigen values and Eigen functions. Solution of homogeneous and general Fredholm integral equations of second kind with separable kernels.

UNIT-II

Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations. Resolvent kernel and its results. Conditions of uniform convergence and uniqueness of series solution. Integral equations with symmetric kernels : Orthogonal system of functions. Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen functions and bilinear form.

UNIT-III

Hilbert-Schmidt theorem. Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem. Solution of Volterra integral equations of second kind with convolution type kernels by Laplace transform. Solution of singular integral equations by Fourier transform. Classical Fredholm theory : Fredholm theorems. Solution of Fredholm integral equation of second kind by using Fredholm first theorem.

Books Recommended for Reference :

1. Lovitt W.V : Integral Equations, Dover Publications.
2. Kanwal R.P : Linear Integral Equations, Academic Press, New York.
3. Gokhroo et.al., : Linear Integral Equations, Navkar Prakashan, Ajmer.
4. Shanti Swaroop : Linear Integral Equations, Krishna Prakashan Mandir, Meerut.

DCC – 15- Advanced Mathematical Statistics-II

UNIT-I

Elementary sampling theory: Distribution of means of sampling from Binomial, Cauchy, rectangular and normal distribution, distribution of second order moments in sampling from normal population, test of significance of difference between two means and two standard deviations tot large samples with modification for small samples and taken from normal population

UNIT-II

Sampling and Exact Sampling Distributions : Theory of Sampling, Distribution of Means of Samples from Binomial, Cauchy, Rectangular and Normal Distributions, Distributions of Second order Moments in Samples from Normal population, Exact sampling Distributions, γ^2 -Distribution, t - Distribution, F - Distribution, Z – Distribution.

UNIT-III

Theory of Attributes : Dichotomy, Manifold classification, Classes, Order of classes, Ultimate class, Class Frequencies, Consistency of data, Association, Independence of attributes, Criterion of independence, Positive association, Negative association, Completely associated, Completely Disassociated, Degree of association, Yule's and Colligation coefficient of association. Tests of Significance for large samples : Test of significance of difference between two means and two standard deviations for large samples with modification for small samples and taken from normal population. Analysis of variance, one and two criteria of classification.

Books Recommended for Reference :

1. Kapur and Saxena : Mathematical Theory of Statistics.
2. Gokhroo, et.al. : Advanced Mathematical Statistics, Navkar Prakashan, Ajmer.
3. Weatherburn : A First Course in Mathematial Statistics.
4. M.G. Kendall : The Advanced Theory of Statistics.
5. Uspensky : Introduction of Mathematical Probability.

DCE – 04 A Advanced Continuum Mechanics – II

UNIT-I

The linear cubical dilatation, compatibility equations for the linear strain components, the rate of strain tensors and the velocity tensor, the rate of rotation vector and the vorticity. properties of the rate of strain tensor, rate of cubical dilatation, Law of conservation of mass and of motion, kinetic equation of state, the first and the second law of thermodynamics and the dissipation function.

UNIT-II

Applications: Linear elasticity assumption and basic equations, generalized Hooke's Law for an isotropic homogeneous solid, compatibility equations. classification of types of problems in linear elasticity, the principle of superposition, the strain energy function, the uniqueness theorem, P-? relationship and the work kinetic energy equation, irrotational flow and the velocity potential, kinetic equation of state and the first law of thermo- dynamics.

UNIT-III

The equation of continuity, the equations of motion, vorticity-stream surface for inviscid flow, Bernoulli equations, irrotational flow and the velocity potential, similarity parameters and fluid flow.

Books Recommended for Reference :

1. D. Frederic and T.S. Chang: Continuum Mechanics, Allyn and Bacon. Inc. Boston
2. Mase. G.E: Continuum Mechanics (Schaum series)
3. Sommerfeld A: Mechanics Deformable bodies.
4. Morton E. Gurtin: An Introduction to Continuum Mechanics (Academic Press)
5. Sharma, K.D.: Continuum Mechanics, Navkar Prakashan, AJMER.

DCE – 04 B Advanced Operations Research – II

UNIT- I

Sequencing models: Solution of sequencing problem - processing n Jobs through 2 machines - processing n Jobs through 3 machines - Processing 2 Jobs through m machines Processing n Job through m machines.

Replacement Models: Replacement of items that deteriorate whose maintenance costs increase with time without change in the money value, replacement of items that fail suddenly, individual replacement policy, group replacement policy.

UNIT-II

Network Analysis: Shortest path problem, minimum spanning tree problem, project planning and control with PERT-CPM.

Queueing Theory: Analysis of the queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population.

UNIT-III

Nonlinear Programming: One and multi variable unconstrained optimization, Kuhn- Tucker conditions for constrained optimization, quadratic programming, Separable programming, convex programming, non-convex programming.

Books Recommended for Reference :

1. T.L. Saaty : Mathematical Methods of Operational Research
2. Sadieni, Friedman and Yaspan : Operations Research
3. S. Vajda : Mathematical Programming
4. Gokhroo et. al.: Advanced Operations Research, Navkar Prakashan, AJMER.
5. Sharma S.D.: Operations Research.
6. Kanti Swarup, P.K. Gupta & D. S. Hira: Operations Research-An Introduction,
7. G Hadley: Nonlinear and Dynamic Programming, Addison-Wesley.
8. O.L Mangasarian: Non -Linear Programming: McGraw Hill.

DCE – 04 C Advanced Discrete Mathematics - II

UNIT-I

Graph Theory : Definition of undirected graph, paths, circuits, cycles and sub graphs, induced sub graphs, degree of vertex, connectivity, planar graphs and their properties. **Trees**: Euler's formula for connected planar graphs, complete and complete bipartite graphs, Kuratowski's theorem (statement only) and its use, spanning trees, cut sets, fundamental cut sets and cycles, minimal spanning trees and Kruskal's algorithm. **Matrix Representation of Graphs**: Euler's theorem on the existence of Eulerian path and circuits, directed graphs, in degree and out degree of vertex, weighted undirected graphs, Dijkstra's algorithm strong connectivity and Warshall's algorithm, directed trees, search trees, tree traversals.

UNIT-II

Grammar and Languages - Phrase structured Grammar, Types of Grammars, Finite State Automata (FSA), Finite State Machine (FSM), Minimization of Finite State Machines, Pumping Lemma. *Boolean algebra, Properties of Boolean algebra, Boolean Expression, Boolean Function, DNF, CNF, Boolean expansion theorem.*

UNIT-III

Switching Circuits : Design and implementation of Digital Network, Switching Circuits. Recurrence Relations and Generating Functions : Discrete Numeric Functions, Recurrence Relations, Recursive Relations, Generating functions.

Books Recommended for Reference:

1. Seymour Lipschutz et al : The Theory and Problems of Discrete Mathematics, Third Edition, McGraw-Hill Book Co.
2. J. E. Hopcroft et al : Introduction to Automata Theory Languages & Computation, Narosa Publishing House, Delhi, 2007.
3. Gokharoo et al : Advanced Discrete Mathematics, Navkar Prakashan, Ajmer.
4. Harary, Addison : Graph Theory, Wesley 1969
5. D. B. West : Introduction to Graph Theory, Prentice Hall 1996.
6. Jonathan Gross et al : Graph Theory and its Applications, CRC 1998.
7. S.K. Sarkar : A Text book of Discrete Mathematics, S Chand and Company Ltd., 2006.
8. C. L. Liu : Elements of Discrete Mathematics, McGraw-Hill Book Co.

DCE – 04 D Relativistic Cosmology

UNIT-I

Hamiltonian principle, Energy - Momentum tensor and its expression for perfect fluid, Principle of Covariance, Principle of equivalence, Condition for flat space time, Einstein's law of gravitation for empty space and material world, Schwarzschild exterior and interior solution for gravitational field. Planetary orbit, Three crucial tests, Advances of perihelion, Gravitational deflection of light, Shift in spectral lines, Weyl hypothesis, Displacement of the Fraunhofer lines, Einstein and de-Sitter models their comparison with the actual universe, Red shift in the spectral line on distant galaxies, Hubble constant, Birkhoff's theorem.

UNIT-II

Basic equations isotropic relativistic cosmology, The singularity of isotropic models, The path of particles of light rays, Horizons, Geodesic deviation, Symmetry and Killing Equations, Conformal Curvature tensor, Algebraic classification of conformal curvature tensor. Relativistic models not obeying cosmological principles, Homogeneous universes, Gödel universe.

UNIT-III

Non-static cosmological models, Robertson-walker model, Robertson-Friedmann model, Doppler effect in Robertson-walker matrices, The scalar tensor theory of Brans and Dicke, Cosmological solution of Brans and Dicke theory.

Books Recommended for Reference:

1. Tolman R.C. : Relativity, Thermodynamics and Cosmology, Oxford University Press.
2. Synge J.L. : Relativity the Special and General, North Holland Publishing company, Amsterdam.
3. Eddington A.S. : The Mathematical Theory of Relativity, Cambridge.
4. Satya Parkash : Relativistic Mechanics
5. Goyal et al : Theory of Relativity, Pragati Prakashan Meerut.

DCE – 05 A Advanced Numerical Methods - II

UNIT-I

Curve fitting and function approximation, least square error criterion, linear regression, polynomial fitting and other curve fitting, approximation of functions by Taylor series and Chebyshev polynomials.

UNIT-II

Numerical solution of ordinary differential equations, Taylor series methods, Euler's and modified Euler's method, Runge-Kutta method upto fourth order, multi step method (Predictor -Corrector Strategies).

UNIT-III

Stability analysis -single and multi step methods, Difference methods for Boundary value problems, ordinary differential equations, boundary value problems, shooting methods. Finite difference methods, difference scheme for non linear boundary value problems of the certain type with the given initial conditions.

Books Recommended for Reference :

1. Jain, Iyengar & Jain : Numerical Analysis
2. Jain M.K. : Numerical Solution of differential equations
3. Gokhroo et. al. : Advanced Numerical Methods, Navkar Prakashan, AJMER

DCE – 04 B Fluid Dynamics

UNIT-I

Kinematics-Lagrangian method. Equation of Continuity. Boundary surfaces. Stream lines, Path lines and streak lines, Velocity potential, Irrotational and rotational motion. Vortex Lines. Equations of Motion-Lagrange's and Euler's equations of motion Bernoulli's theorem, Equation of motion by flux method. forces.

UNIT-II

Equations referred to moving axes, Impulse reactions, Stream function, Irrotational motion in two-dimensions, Complex velocity potential, Sources, Sinks, Doublets and their images. Conformal mapping, Milne-Thomson circle theorem.

UNIT-III

Two-dimensional Irrotational motion product by motion of circular co-axial and elliptic cylinders in an infinite mass of liquid. Kinetic energy of liquid. Theorem of Blasius, Motion of a sphere through a liquid at rest at infinity, Liquid streaming past a fixed sphere. Equation of motion of a sphere, Stoke's stream function. Vortex motion and its elementary properties, Kelvin's proof of permanence, Motions due to circular and rectilinear vortices.

Books Recommended for Reference:

1. M.Ray : A Text Book of Hydrodynamics.
2. Gokharoo et al : Fluid Dynamics, Navkar Prakashan, Ajmer.
3. Shanti Swarup : Fluid Dynamics, Krishna Prakashan Media, Meerut
4. M.D. Raisinghania : Fluid Dynamics, S. Chand & Co., New Delhi.

DCE – 05 C Dynamics of Rigid Bodies

UNIT-I

Moment and products of inertia: Moment of inertia of a body with respect to a given line, product of inertia in simple cases, theorem of parallel axes, theorem of six constants of a body, momental ellipsoid, momental ellipse, principal axes. D'Alembert's principle: The general equations of motion of a rigid body. Motion of centre of inertia and motion relative to centre of inertia.

UNIT-II

Motion about a fixed axis: Moment of momentum of a body about the fixed axis, kinetic energy, motion of the effective forces about the axis, equation of motion, motion under torque, the compound pendulum, Centre of suspension, centre of oscillation, centre of percussion. Motion of a rigid body in two dimensions under finite forces: Dynamical equation of motions, moment of momentum or angular momentum, Dynamical equation, conservation of momentum (linear and angular), kinetic energy, equation of Vis Viva.

UNIT-III

Conservation of momentum and energy: Principle of conservation of linear momentum, Principle of conservation of angular momentum, when impulsive forces act, sudden fixtures, principle of conservation of energy, conservative forces. Lagrange's equations of motion: Generalized co-ordinates, degree of freedom, Lagrange's function, principle of energy, small oscillation. Hamilton's equations: Hamilton's equations of motion, Hamilton's principle and principle of least action.

Books Recommended for Reference:

1. S.L.Loney : Dynamics
2. A.S.Ramsay : Dynamics
3. Gokhroo et al : Dynamics of Rigid Bodies, Navkar Prakashan, Ajmer.
4. Ray & Sharma : A Text Book of dynamics of a Rigid Body.

DCE – 05 D Generalized Hypergeometric Functions – II

UNIT-I

Meijer's G-Function: Definition, Nature and convergence conditions for the contours, special cases, Identities, Transformation formulas, Differentiation formulas, recurrence relations, Contiguous functions, relations. Simple finite and infinite integrals involving G-function

UNIT-II

Differential equation for G function, series for G function, Asymptotic expansion of G function, Mellin and Laplace transforms of G-function. **H-function** : Definition, Convergence conditions, Series representations, Special cases, Transformation formulas,

UNIT-III

H-function : Identities, Differentiation formulas, Multiplication formulas, Recurrence relations, Contiguous function relations, finite and infinite Integrals involving H-functions.

Books Recommended for Reference:

1. Mathai A.M. et al : The *H*-function with applications in Statistics and other disciplines, Wiley Eastern Ltd., New Delhi, (1978) (Chapters 1 to 3)
2. Mathai et al : Generalized Hypergeometric function with Application in Statistics and physical Sciences, Springer Verlag
3. Gokhroo et al : Generalized Hypergeometric Functions, Navkar Prakashan, Ajmer.
4. Yudell L Luke : The Special Function and their approximation: Academic Press.