University of Rajasthan
Jaipur

SYLLABUS

M.A./M.Sc. Mathematics
(Annual Scheme)

Previous Examination 2021

Final Examination 2022

Dy. Registrar (Acad.)
University of Rajasthan
JAIPUR

M.A./M.Sc.(Previous) Mathematics Examination

Scheme of Examination : Annual Scheme
Note: Papers I to V are compulsory

Paper – I: Advanced Abstract Algebra
Teaching : 6 Hours per Week
Examination : Common for Regular/Non-collegiate Candidates

3 Hrs. duration **Theory Paper** **Max. Marks 100**

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1: Direct product of groups (External and Internal). Isomorphism theorems – Diamond isomorphism theorem, Butterfly Lemma, Conjugate classes (Excluding p-groups), Commutators, Derived subgroups, Normal series and Solvable groups, Composition series, Refinement theorem and Jordan-Holder theorem for infinite groups.

Unit 2: Sylow's theorems (without proof), Cauchy's theorem for finite abelian groups. Euclidean rings. Polynomial rings and irreducibility criteria. Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dual maps, Annihilator.

Unit 3: Field theory – Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, Normal extensions. Splitting fields.
Galois theory – the elements of Galois theory, Automorphism of extensions, Fundamental theorem of Galois theory, Solutions of polynomial equations by radicals and Insolvability of general equation of degree five by radicals.

Unit 4: Matrices of a linear maps, Matrices of composition maps, Matrices of dual map, Eigen values, Eigen vectors, Rank and Nullity of linear maps and matrices, Invertible matrices, Similar matrices, Determinants of matrices and its computations, Characteristic polynomial, minimal polynomial and eigen values.

Unit 5: Real inner product space, Schwartzs inequality, Orthogonality, Bessel's inequality, Adjoint, Self adjoint linear transformations and matrices, Orthogonal linear transformation and matrices, Principal Axis Theorem.

Raj Kumar

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M.A./M.Sc. (FINAL) MATHEMATICS

Scheme of Examination : Annual Scheme

Note: 1. Papers I and II are compulsory

2. Candidates are required to opt any three papers from Paper III to XIII

COMPULSORY PAPERS

Paper – I: Analysis and Advanced Calculus

Teaching : 6 Hours per Week

Examination : Common for Regular/Non-collegiate Candidates

3 Hrs. duration | **Theory Paper** | **Max. Marks 100**

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1: Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergent, Cauchy sequence. Complete metric space, Baire's category theorem, compact sets, compact spaces, Separable metric space and connected metric spaces.

Unit 2: 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. Weak convergence of a sequence of bounded linear transformations.

Unit 3. Equivalent norms, Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem. Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples.

Unit 4: Inner product spaces. Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Phythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples, Orthonormal sets, Bessel's inequality, Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.

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Paper – III: Differential Equations and Special Functions

Teaching : 6 Hours per Week

Examination : Common for Regular/Non-collegiate Candidates

3 Hrs. duration **Theory Paper** **Max. Marks 100**

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1: Non-linear ordinary differential equations of particular forms. Riccati's equation –General solution and the solution when one, two or three particular solutions are known. Total Differential equations. Partial differential equations of second order with variable co-efficients- Monge's method.

Unit 2: Classification of linear partial differential equation of second order, Canonical forms. Cauchy's problem for first order partial differential equations, Method of separation of variables, Laplace, Wave and diffusion equations, Linear homogeneous boundary value problems. Eigen values and eigen functions. Strum-Liouville boundary value problems. Orthogonality of eigen functions. Reality of eigen values.

Unit 3: Calculus of variation – 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, Series solution of a second order linear differential equation near a regular singular point (Method of Frobenius) for different cases.

Unit 4: Gauss hypergeometric function and its properties, Integral representation, Linear 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. Legendre polynomials and functions $P_n(x)$ and $Q_n(x)$.

Unit 5: Bessel functions $J_n(x)$, Hermite polynomials $H_n(x)$, Laguerre and Associated Laguerre polynomials.

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Reference Books:

1. J.L.Bansal and H.S.Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
4. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.
5. E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, Orient Longman, 1902.
8. A.R.Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

Paper- IV: Differential Geometry and Tensor Analysis

Teaching : 6 Hours per Week

Examination : Common for Regular/Non-collegiate Candidates

3 Hrs. duration **Theory Paper** **Max. Marks 100**

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1: Space curves, Tangenet, Contact of curve and surface, Osculating plane, Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Existence and Uniqueness theorems, Bertrand curves, Involute, Evolutes.

Unit 2: Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and sufficient condition that a surface $\zeta = f(\xi,\eta)$ should represent a developable surface. Conoids, Inflexional tangents, Singular points, Indicatrix. Metric of a surface, First, second and third fundamental forms, Weingarten equations. Fundamental magnitudes of some important surfaces, Orthogonal trajectories.

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Unit 3: Normal curvature, Meunier's theorem. Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussian curvature, Umbilics. Radius of curvature of any normal section at an umbilic on $z = f(x,y)$. Radius of curvature of a given section through any point on $z = f(x,y)$. Lines of curvature, Principal radii, Relation between fundamental forms. Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asymptotic line. Gauss's formulae, Gauss's characteristic equation, Mainardi-Codazzi equations. Fundamental existence theorem for surfaces, Parallel surfaces, Gaussian and mean curvature for a parallel surface, Bonnet's theorem on parallel surfaces.

Unit 4: Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic curvature and Torsion, Normal angle, Gauss-Bonnet Theorem.
Tensor Analysis– Kronecker delta. Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, Relative tensor. Riemannian space. Metric tensor, Indicator, Permutation symbols and Permutation tensors.

Unit 5: Christoffel symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Field of parallel vectors, Reimann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flate space, Isotropic point, Schur's theorem.

Reference Books:

1. R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.
2. Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.
3. Barry Spain, Tensor Calculus, Radha Publ. House Calcutta,1988.
4. J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog , 2013.
5. T.J. Willmore - An Introduction to Differential Geometry. Oxford University Press.1972.
6. Weatherbum, Reimanian Geometry and Tensor Clculus, Cambridge Univ. Press, 2008.
7. Thorpe, Elementary Topics in Differential Geometry, Springer Verlag, N.Y. (1985).
8. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice Hall, 1977.

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Paper – V: Mechanics

Teaching : 6 Hours per Week

Examination : Common for Regular/Non-collegiate Candidates

3 Hrs. duration **Theory Paper** **Max. Marks 100**

Note : This paper is divided into FIVE Units. TWO questions will be set from each Unit. Candidates are required to attempt FIVE questions in all taking ONE question from each Unit. All questions carry equal marks.

Unit 1: D'Alembert's Principle. General equations of motion of a rigid body. Motion of the centre of inertia and motion relative to the centre of inertia. Motion about a fixed axis. The compound pendulum, Centre of percussion. Conservation of momentum (linear and angular) and energy for finite as well as impulsive forces.

Unit 2: Motion in three dimensions with reference to Euler's dynamical and geometrical equations. Motion under no forces, Motion under impulsive forces. Motion of a Top.

Unit 3: Lagrange's equations for holonomous dynamical system, Energy equation for conservative field, Small oscillations, Motion under impulsive forces. Hamilton's equations of motion, conservation of energy, Hamilton's Principle and Principle of Least Action.

Unit 4: Kinematics of ideal fluids. Lagrange's and Euler's methods. Equation of continuity in Cartesian, cylindrical and spherical polar coordinates. Boundary surface. Stream-lines, path-lines ,velocity potential, rotational and irrotational motion.

Unit 5: Euler's hydrodynamical equations. Bernoulli's theorem. Helmholtz equations. Cauchy's integrals, Motion due to impulsive forces. Motion in two-dimensions: Stream function, Complex potential. Sources, Sinks, Doublets, Images in two-dimensions.

Reference Books:

1. N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.
2. M. Ray and H.S. Sharma, A Text Book of Dynamics of a Rigid Body, Students' Friends & Co., Agra, 1984.
3. M.D. Raisinghania, Hydrodynamics, S. Chand & Co. Ltd., N.D. 1995.
4. M. Ray and G.C. Chadda, A Text Book on Hydrodynamics, Students' Friends & Co., Agra, 1985.
5. H. Goldstein, Classical Mechanics, Narosa, 1990.
6. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill, 1991.
7. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

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