UNIVERSITY OF RAJASTHAN
JAIPUR
SYLLABUS

M.A./M.Sc. MATHEMATICS

(ANNUAL SCHEME)

M.A./M.Sc. (Previous) Examination 2018
M.A./M.Sc. (Final) Examination 2019
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, Schwartz inequality, Orthogonality, Bessel's inequality,
Adjoint, Self adjoint linear transformations and matrices, Orthogonal linear transformation and
matrices, Principal Axis Theorem.

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice Hall of India (PHI), New Delhi, 2004
   (Asia) Pvt Ltd Singapore, 2004

Paper – II: Real Analysis and Topology  
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: Algebra and algebras of sets, Algebras generated by a class of subsets, Borel sets, Lebesgue measure of sets of real numbers, Measurability and Measure of a set, Existence of Non-measurable sets, Measurable functions, Realization of non-negative measurable function as limit of an increasing sequence of simple functions, Structure of measurable functions, Convergence in measure, Egoroff's theorem.


Unit 3: Lebesgue integration on \( \mathbb{R}^2 \), Fubini's theorem, \( L^p \)-spaces, Holder-Minkowski inequalities. Completeness of \( L^p \)-spaces, Topological spaces, Subspaces, Open sets, Closed sets, Neighbourhood system, Bases and sub-bases.

Unit 4: Continuous mapping and Homeomorphism, Nets, Filters, Separation axioms (To, T1, T2, T3, T4). Product and Quotient spaces.

Unit 5: Compact and locally compact spaces. One point compactification theorem. Connected and Locally connected spaces, Continuity and Connectedness and Compactness.

Reference Books:
5. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
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 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 formulas, 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.

Reference Books:
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: Conoids, Inflexional tangents, Singular points, Indicatrix. Space curves, Tangent, 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: Envelope, Edge of regression, Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and sufficient condition that a surface \( \zeta = f(x, y) \) should represent a developable surface. Skew surface-parameter of distribution. Metric of a surface, First, second and third fundamental forms. Fundamental magnitudes of some important surfaces, Orthogonal trajectories, Normal curvature, Mean curvature, Meunier's theorem.

Unit 3: 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, Weingarten equations, 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.


Reference Books:
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. Motion of a rigid body in two dimensions under finite and 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. Conservation of momentum (linear and angular) and energy for finite as well as impulsive forces.

Unit 3: Lagrange’s equations for holonomous dynamical system. Energy equation for conservative field, Small oscillations, Motion under impulsive forces. Motion of a Top. 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:
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, Sequences in a metric space, Convergent Cauchy sequence. Complete metric space, Examples of Complete & Incomplete metric spaces. Baire’s category theorem, Ascoli-Arzelà theorem, compact sets, compact spaces and connected metric spaces. Separable metric space with examples.


Reference Books:
Paper II  VISCOUS FLUID DYNAMICS
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: Viscosity, Analysis of stress and rate of strain, Stokes' law of friction, Thermal conductivity and generalized law of heat conduction, Equations of state and continuity, Navier-Stokes' equations of motion, Vorticity and circulation, Dynamical similarity, Inspection and dimensional analysis, Buckingham theorem and its application, Non-dimensional parameters and their physical importance: Reynolds number, Froude number, Mach number, Prandtl number, Eckart number, Grashoff number, Brinkmann number, Non-dimensional coefficients: Lift and drag coefficients, Skin friction, Nusselt number, Recovery factor.

Unit 2: Exact solutions of Navier-Stokes' equations, Velocity distribution for plane couette flow, Plane Poiseuille flow, Generalized plane Couette flow, Hagen-Poiseuille flow, Flow in tubes of uniform cross-sections, Flow between two concentric rotating cylinders.

Unit 3: Stagnation point flows: Hiemenz flow, Homann flow. Flow due to rotating disc, Concept of unsteady flow, Flow due to plane wall suddenly set in the motion (Stokes' first problem), Flow due to an oscillating plane wall (Stokes' second problem), Starting flow in plane Couette motion, Suction/injection through porous wall.

Unit 4: Equation of energy, Temperature distribution: Between parallel plates, in a pipe, between two concentric rotating cylinders, variable viscosity plane Couette flow, temperature distribution of plane Couette flow with transpiration cooling.

Unit 5: Theory of very slow motion: Stokes' and Oseen's flows past a sphere, Concept of boundary layer, Derivation of velocity and thermal boundary equations in two-dimensional flow. Boundary layer on flat plate (Balsius-Topfer solution), Simple solution of thermal boundary layer equation for Pr = 1.

Reference Books:
OPTIONAL PAPERS

Candidates are required to opt any three papers given below:

Paper – III: Continuum 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: Cartesian Tensors, Index notation and transformation laws of Cartesian tensors. Addition, Subtraction and Multiplication of cartesian tensors, Gradient of a scalar function, Divergence of a vector function and Curl of a vector function using the index notation. ε-δ identity. Conservative vector field and concept of a scalar potential function. Stokes', Gauss' and Green's theorems.


Reference Books:
Paper – IV: Boundary Layer Theory
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.


Reference Books:
Paper – V: Mathematical Programming
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 2: Integer programming. Gomory’s algorithm for the all integer programming problem, Branch and Bound technique. Quadratic forms. Lagrange function and multiplier.


Unit 5: Dynamic programming, Principle of optimality due to Bellman, Solution of a LPP by dynamic programming.

Reference Books:

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 2: Normal hypergeometric, rectangular, Negative Binomial Beta, Gamma and Cauchy's distribution. Methods of least squares and curve fitting, Correlation and Regression coefficients, Association of Attributes.


Unit 4: Test of significance and difference between two means and two standard deviations for large samples with modification for small samples and taken from normal population. Analysis of variance, Simple cases (One criteria and two criteria of classification).


Reference Books:

Paper – VII: Combinatorics and Graph Theory
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.


Reference Books:

1. N. Deo, Graph Theory with Applications to Computer Science, Prentice-Hall of India, 1979.
Paper- VIII: Integral Transforms and Integral Equations
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.


Solution of ordinary differential equations with constant and variable coefficients by Laplace transform. Application to the solution of Simple boundary value problems by Laplace, Fourier and infinite Hankel transforms.


Reference Books:
Paper- IX: Relativity and Cosmology
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: Relative Character of space and time, Principle of Relativity and its postulates, Derivation of special Lorentz transformation equations, Composition of Parallel velocities, Lorentz-Fitzgerald contraction formula, Time dilatation, Simultaneity, Relativistic transformation formulae for velocity, Lorentz contraction factor, Particle acceleration, Velocity of light as fundamental velocity, Relativistic aberration and its deduction to Newtonian theory.

Unit 2: Variation of mass with velocity, Equivalence of mass and energy, Transformation formulae for mass, Momentum and energy, Problems on conservation of mass, Momentum and energy, Relativistic Lagrangian and Hamiltonian, Minkowski space, Space-like, Time-like and Light-like intervals, Null cone, Relativity and Causality, Proper time, World line of a particle.

Unit 3: Principles of Equivalence and General Covariance, Geodesic postulate, Mach’s principle, Newtonian approximation of equation of motion, Einstein’s field equation for matter and empty space, Reduction of Einstein’s field equation to Poisson’s equation, Schwarzschild exterior metric, its isotropic form and singularity, Relativistic differential equation for orbit of the planet.

Unit 4: Three crucial tests in general Relativity and their detailed descriptions, Analogues of Kepler’s laws in General Relativity, Trace of Einstein tensor and energy-momentum tensor for perfect fluid, proof of its expression for perfect fluid, Schwarzschild interior metric and boundary conditions, Radar Echo delay (Fourth test).

Unit 5: Lorentz invariance of Maxwell’s equations and their tensor form, Lorentz force on charged particle, Energy-momentum tensor for electromagnetic field, Reissner-Nordstrom metric for spherically charged particle.
Cosmology – Einstein’s field equation with cosmological term, static cosmological models (Einstein and de-Sitter) and their physical and geometrical properties. Red Shift in non-static form of de-Sitter line-element. Einstein-space, Hubble’s law, Weyl’s postulate.

Reference Books:
Paper – X: Industrial Mathematics  
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 3: Sensitivity Analysis in Linear Programming Problems. Various models of Assignment problems, alternate optimal solutions, post optimality analysis in transportation.

Unit 4: Inventory Models. EOQ models with and without shortages. EOQ models with constraints.

Unit 5: Replacement and Reliability models. Replacement of items that deteriorate, Replacement of items that fail completely. Reliability Theory – Coherent structure, Reliability of systems of independent components, Bounds on system reliability, Shapes of the system reliability function, Motion of aging, Parametric families of life distribution with Monotone failure rate.

Reference Books:

Paper – XI: Magnetohydrodynamics  
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 2: Reynolds number, Mach number, Prandtl number, Magnetic Reynolds number, Magnetic pressure number, Hartmann number, Magnetic parameter, Magnetic Prandtl number and Nusselt number. Hartmann plane Poiseuille flow and plane Couette flow including temperature distribution. MHD flow in a tube of rectangular cross-section. MHD pipe flow. MHD flow in annular channel. MHD flow between two rotating coaxial cylinders.

Unit 3: MHD flow near a stagnation point. MHD Reyleigh's flow. MHD Stoke's flow past a sphere. MHD Oseen’s flow past a sphere. MHD boundary layer flow past a flat plate in an aligned magnetic flow. Wilson’s numerical solution technique.


Reference Books:

Paper- XII: Advanced Numerical 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 2: Solution of polynomial equations – Polynomial equation, Real and complex roots, Synthetic division, the Birge-Vieta, Burstow and Graeffe’s root squaring method. System of simultaneous Equations (Linear)- Direct method, Method of determinant, Gauss-Jordan, LU-Factorizations-Doolitte’s, Crout’s and Cholesky’s. Partition method. Method of successive approximate-conjugate gradient and relaxation methods.


Unit 5: BVP’s of ordinary differential Equations – Boundary value problems (BVP’s), Shooting methods, Finite difference methods. Difference schemes for linear boundary value problems of the type $y'' = f(x, y)$, $y''' = f(x, y, y')$ and $y^{iv} = f(x, y)$.

Reference Books:

Paper – XIII: Computer Applications
Teaching: 4 Hours per Week for Theory Paper.
Examination: For Regular candidates only.
3 Hrs. duration Theory Paper Max. Marks 70

2 Hrs. duration Practical Max. Marks 30
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
Computer languages, System software and application software. Windows: Graphical user interface, control panel and all features there in files and folders management. Using Accessories, Getting help, copying, moving and sharing information between programs. Setting up printer and fonts. Configuring modem.

Unit 2:
Unit 3
Arithmetic expressions, Input-output, Conditional statements, Implementing loops in programs. Defining and manipulating arrays,

Unit 4
Processing character strings, functions. Files in C. Simple computer programming. Programming using Matlab/Mathematica – Variables, Vector and Matrix Computation, Built-in-functions, Plotting, output, M-files,

Unit 5

Reference Books:

Practical
Teaching: 2 Hours per week
Examination: 2 Hours duration

Max. Marks: 30


Distribution of Marks:
Two Practical – 10 Marks each = 20 Marks
Practical Record = 05 Marks
Viva-Voce = 05 Marks
Total Marks = 30 Marks

Note:
1. Problems will be solved by using C/C++/MATLAB/SCLAB
2. Each candidate is required to appear in the Practical examination to be conducted by internal and external examiners. External examiner will be appointed by the University through BOS and internal examiner will be appointed by the Head of the Department/Principal of the College.
3. Each candidate has to prepare his/her practical record.
4. Each candidate has to pass in Theory and Practical examinations separately.

Dy. Regent
Academic
University