

UNIVERSITY OF RAJASTHAN, JAIPUR



SYLLABUS

SCHEME OF EXAMINATION AND
COURSES OF STUDY

FACULTY OF SCIENCE & SOCIAL SCIENCES

M.A./M.Sc. MATHEMATICS

2013-2015

SCHEME OF EXAMINATION

(Annual Scheme)

Each Theory Paper

3 Hrs. Duration

100 Marks

Dissertation/Thesis/

Survey Report/Field

Work, if any.

100 Marks

1. The number of papers and the maximum marks for each paper practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in the theory part as well as in practical part (wherever prescribed) of a subject/paper separately.
2. A candidate for a pass at each of the Previous and the Final Examinations shall be required to obtain :
 - (i) At least 36% marks in the aggregate of all the papers prescribed for the examination, and
 - (ii) At least 36% marks in practical(s) wherever prescribed at the examination, provided that if a candidate fails to secure at least 25% marks in each individual paper at the examination and also in the Dissertation/Survey report/Field work wherever prescribed, he shall be deemed to have failed at the examination notwithstanding his having obtained the minimum percentage of marks required in the aggregate for that examination. No division will be awarded at the Previous and the Final Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examination taken together, as noted below:

First Division	60%	}	of the aggregate marks taken together of the Previous and the Final Examination.
Second Division	48%		

All the rest will be declared to have passed the examination.
3. If a candidate clears any Paper(s)/Practical(s)/Dissertation prescribed at the Previous and/or Final Examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz. 25% (36% in the case of practical) shall be taken into account in respect of such Paper(s)/Practical(s)/Dissertation are cleared after the ex-

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piry of the aforesaid period of three years; provided that in case where a candidate required more than 25% marks in order to reach the minimum aggregate as many mark out of those actually secured by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate.

4. The Thesis/Dissertation/Survey Report/Field Work shall be typewritten and submitted in triplicate so as to reach the office of the Registrar at least 3 weeks before the commencement of the theory examinations. Only such candidates shall be permitted to offer Dissertation/Field Work/Survey Report/Thesis (if provided in the scheme of examination) in lieu of a paper as have secured at least 55% marks in the aggregate of all the papers prescribed for the previous examination in the case of annual scheme irrespective of the number of papers in which a candidate actually appeared at the examination.

N.B. Non-collegiate candidates are not eligible to offer dissertation as per provisions of O. 170-A.

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: Euclidean rings. Modules. Submodules, Quotient modules, Direct sums and Module Homomorphisms. Generation of modules, Cyclic modules. 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, Simi-

lar matrices. Determinants of matrices and its computations, Characteristic polynomial and eigen values.

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

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. Algebra 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, Realisation 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 2: Weierstrass's theorem on the approximation of continuous function by polynomials. Lebesgue integral of bounded measurable functions, Lebesgue theorem on the passage to the limit under the integral sign for bounded measurable functions. Summable functions, Space of square summable functions. Fourier series and coefficients. Parseval's identity, Riesz-Fisher theorem.

Unit 3: Lebesgue integration of \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 (T_0, T_1, T_2, T_3, T_4). Product and Quotient spaces.

Unit 5: Compact and locally compact spaces. Tychonoff's one point compactification. Connected and Locally connected spaces, Continuity and Connectedness, and Compactness.

Paper - III : Differential 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.

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, Cauchy's problem. Method of separation of variables. Laplace, Wave and diffusion equations. Canonical forms. Linear homogeneous boundary value problems. Eigen values and eigen functions. Sturm-Liouville boundary value problems. Orthogonality of eigen functions. Reality of eigen values.

Unit 3: Calculus of variations—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 of 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) with special reference to Gauss hypergeometric equation and Legendre's equation.

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.

Paper - IV : Differential Geometry

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, 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. Conoids, Inflexional tangents, Singular points, Indicatrix.

Unit 2: Envelope, Edge of regression, Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and

sufficient condition that a surface $\mathfrak{S} = F(\xi, \eta)$ should represent a developable surface. Metric of a surface, First, second and third fundamental forms. Fundamental magnitudes of some important surfaces, Orthogonal trajectories. Normal 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. 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, Riemann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor. Flat space, Isotropic point, Schur's theorem.

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. The general equations of motion of a rigid body. Motion of centre of inertia and motion relative to 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 fluid. Lagrange's and Euler's methods. Equation of continuity in Cartesian, cylindrical and spherical polar coordinates. Boundary surface. Stream-lines, path-lines and stream lines velocity potential irrotational motion.

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

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~~ 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:** 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. Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping.**Unit 2:** 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. Inner product spaces. Hilbert space and its properties.**Unit 3:** 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. Adjoint of an operator on a Hilbert space. Self-adjoint. Positive, Normal and Unitary operators and their properties.**Unit 4:** Projection on a Hilbert space. Invariance. Reducibility. Orthogonal projections. Eigen values and eigen vectors of an

Derivatives of a continuous map from an open subset of Banach space to Banach space. Rules of derivation. Derivative of a composite, Directional derivative. Mean value theorem and its applications. Partial derivatives and Jacobian Matrix.

Unit 5: Continuously differentiable maps. Higher derivatives. Taylor's formula. Inverse function theorem. Implicit function theorem. Step function regulated function Primitives and integral. Differentiation under the integral sign. Riemann integral of function of real variable with values in normed linear space. Existence and uniqueness of solutions of ordinary differential equations of the type $x' = f(t, x)$.

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, Stoke's 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-section, 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' 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 $Pr=1$.

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.

- Unit 2:** Continuum approach. Classification of continuous media, Body forces and surface forces. Components of stress tensor. Force and Moment equations of equilibrium. Transformation. law of stress tensor. Stress quadric. Principal stress and principal axes. Stress invariants and stress deviator. Maximum shearing stress.
- Unit 3:** Lagrangian and Eulerian description of deformation of flow. Comoving derivative, Velocity and Acceleration. Continuity equation. Strain tensors. Linear rotation tensor and rotation vector, Analysis of relative displacements. Geometrical meaning of the components of the linear strain tensor, Properties of linear strain tensors. Principal axes, Theory of linear strain. Linear strain components. Rate of strain tensors. The vorticity tensor. Rate of rotation vector and vorticity, Properties of the rate of strain tensor, Rate of cubical dilation.
- Unit 4:** Law of conservation of mass and Eulerian continuity equation. Reynolds transport theorem. Momentum integral theorem and equation of motion. Kinetic equation of state. First and the second law of Thermodynamics and dissipation function. Applications (Linear elasticity and Fluids)-Assumptions and basic equations. Generalised Hook's law for an isotropic homogeneous solid.
- Unit 5:** Compatibility equations (Beltrami-Michell equations). Classification of types of problems in linear elasticity. Principle of superposition, Strain energy function. Uniqueness theorem, p - p relationship and work kinetic energy equation, Irrotational flow and Velocity potential. Kinetic equation of state and first law of Thermodynamics. Equation of continuity. Equations of motion. Vorticity-stream surfaces of inviscid flow, Benoullis equations. Irrotational flow and velocity potential. Similarity parameters of fluid flow.

Paper—IV : Information 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.

Unit 1: Basic concepts of probability, Sample spaces, Probability measure. Theorems of addition and multiplication. Conditional probability, Baye's theorem. Random variable, Discrete and Continuous probability distributions.

Unit 2: Communication processes. Entropy as measure of uncertainty and information, Shannon's entropy and entropies of order α . Algebraic properties and possible interpretations. Analytical properties and Inequalities, Joint and Conditional entropies, Mutual information. Extension of definition of entropies to continuous memoryless channels and their properties.

Unit 3: Noiseless coding, Unique decipherability, Conditions of existence of instantaneous codes, its extension to uniquely decipherable codes, Noiseless coding theorem. Construction of optimal codes. Discrete memoryless channels. Models for communication channel capacity. Decoding schemes. Fundamental theorems. Exponential error bound weak converse of Fundamental theorem.

Unit 4: Characterisation theorem for entropies due to Shannon, Tevberg, Chaundy and Mechleed, Kardall, Daroczy, Camphall and Hyarda and Chavat.

Unit 5: Error correcting codes. Minimum distance, Principle and error correcting properties. Hamming bounds, Parity check coding. Upper and lower bounds of parity check codes.

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.

Unit 1: Derivation of boundary layer equations for two-dimensional flow. Boundary layer along a flat plate (Blasius-Topfer solution). Characteristic boundary layer parameters. Similar solutions. Exact solution of the steady state boundary layer equations in two-dimensional flow. Flow past a wedge. Flow along the wall of a convergent channel. Boundary layer separation. Flow past a symmetrically placed cylinder (Blasius series solution). Gortler new series method.

Unit 2: Plane free jet, Circular jet, Plane wall jet. Prandtl-Mises transformation and its application of plane free jet. Axially symmetrical boundary layers on bodies at rest. Boundary layer on a body of revolution. Mangler's transformation.

Unit 3: Three-dimensional boundary layers—Boundary layer flow on yawed cylinder. Growth of three-dimensional boundary layer on a rotating disc impulsively set in motion. Unsteady boundary layers—Method of successive approximations, Boundary layer growth after impulsive start of motion and in accelerated motion, Boundary layer for periodic flow (Pulsatile pressure gradient)

Unit 4: Approximate methods for the solution of the boundary layer equations. Karman momentum integral equation. Karman-Pohlhausen method and its application. Waltz-Thwaites method. Energy integral equation. Derivation of two-dimensional thermal boundary layer equation for flow over a plane wall.

Unit 5: Forced convection in a laminar boundary layer on a flat plate, Crocco's first and second integrals. Reynolds analogy. Temperature distribution in the spread of a jet—(i) Plane free jet, (ii) Circular jet (iii) Plane wall jet. Free convection from a heated vertical plate. Thermal-energy integral equation. Approximate solution of the Pohlhausen's problem of free convection from a heated vertical plate.

Paper—~~5~~ ^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 1: Separating and supporting hyperplane theorems. Revised Simplex method for linear programming problems (LPP), Bounded variable problem. Convex function.

Unit 2: Integer programming. Gomory's algorithm for the all integer programming problems, Branch and Bound techniques. Quadratic forms. Lagrange function and multiplier.

Unit 3: Non-linear programming problems (NLPP) and its fundamental ingredients. Necessary and Sufficient conditions for saddle points. Kuhn-Tucker theorem. Convex separable programming algorithm.

Unit 4: Kuhn-Tucker conditions for optimisation for NLPP. Quadratic programming, Wolf's method. Beale's method. Duality in Quadratic programming.

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

Paper—VII : Astronomy

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: Celestial Sphere-Refraction, Meridian circle, Time Heliographic coordinates.

Unit 2: Aberration. Parallax.

Unit 3: Proper Motions of stars, Definition of proper motions, Relation between proper motions, Tangential velocity and parallax. Radial velocity. Measurement of proper motion, Components of proper motion at different epochs referred to the same equatorial system. Components of proper motion referred to the mean equators of two different epochs, Mean and apparent co-ordinates. Solar motion and parallactic motion. Secular parallax. The solar motion in radial velocity. Solar motion in the general case, Statistical parallax. Determination of the solar apex from proper motions. Determination of the solar motion from radial velocities.

Unit 4: Occultator and Eclipses, Binary Star Orbits (visual binary stars). Elements of the true orbit of visual binary Kowalsky's method of determining the elements of visual binary orbit. Zwierv's method of determining the elements of visual binary orbit, The Masses of stars. Dynamical parallaxes. Spectroscopic binaries. Velocity curve. Method of Lehmann filhes. Two spectra visible. Mass function. Masses of spectorscopic binaries. Eclipsing binary star.

Unit 5: Two body problem—Differential equations and integrals of the problem. Reduction to relative coordinates. Integration

of the two body problem in the plane. Motion in the orbit. The case of parabolic orbit, Additional considerations. Integrals of the one body problem, Lagrange's solution of three bodies, Periodic solutions in the neighbourhood of the points of liberation. Planetary motions. Planetary phenomena, Precession and Mutation.

Paper—~~VII~~ ^{VI} : Mathematical Theory of Statistics

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: Sample space—Combination of events. Statistical independence, Conditional probability. Baye's repeated trials. Random variable, Distribution function, Probability function. Density function, Mathematical expectation, Generating function, Continuous probability distribution, Characteristic function. Fourier's inversion, Chebyshev and Kolmogroeva inequality. Weak and strong laws of large numbers.

Unit 2: Normal Hypergeometric, Rectangular, Negative Binomial, Beta, Gamma and Cauchy's distributions. Methods of least square and curve fitting, Correlation and Regression coefficients, Association of Attributes.

Unit 3: Interpolation—Introduction, Newton-Gregory theorem. Newton's, Lagrange's, Gauss's and Stirling's formulae. Index numbers—Introduction, Price relatives, Quantity relatives, Value relatives, Link and chain relatives. Aggregate methods, Fisher's ideal Index. Change of the base of the index numbers. Elementary sampling theory. Distribution of means of samples for Binomial Cauchy, rectangular and normal population. Exact distributions of x^2 , t, z and F. Statis-

tics in samples from a normal population, their simple properties and applications.

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).

Unit 5: Elementary Statistical theory of Estimation of efficient, Fisher's criteria for the estimator, Consistent, Efficient and Sufficient estimator, Method of maximum likelihood. Maximum Likelihood Estimator, Other methods of estimation. Methods of moments, Minimum variance, Minimum Chi-square and Least squares.



Paper—VI : 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.

Unit 1: Combinatorics—Counting of sets and multisets. Binomial and multinomial numbers. Unordered selection with repetitions, Selection without repetition. Counting objects and functions. Functions and the Pigeonhole principle. Inclusion and exclusion principle.

Unit 2: Discrete numeric functions and combinatorial problems. Generating functions and recursions. Power series and their algebraic properties. Homogeneous and non-homogeneous linear recursions.

Unit 3: Graphs—Basic terminology, Simple graphs, Multi graphs and

Weighted graphs. Walk and connectedness. Paths and circuits. Shortest path in weighted graphs, Eulerian paths and circuits. Hamiltonian paths and circuits.

Travelling salesman problem, operations on graphs. Trees—Trees, Rooted trees, Paths lengths in rooted trees, spanning trees, minimum spanning trees.

Unit 4: Cut sets—Cut-sets, Cut vertices. Fundamental cut sets, Connectivity and separativity. Net work flows, Max-flow min-cut theorem.

Planar Graphs—Combinatorial and geometric graphs Kuratowski's graphs. Euler's formula. Detection of planarity Geometric dual. Thickness and Crossing number.

Unit 5: Graph Colouring. Vertex colouring, Edge colouring and Map colouring. Chromatic number. Chromatic polynomials, The four and five colour theorems.

Digraphs—Binary relations, Directed graphs and Directed trees, Arborescence, Polish notation method, Tournaments, Counting of Labelled Trees—Cayley's theorem. Counting methods, Polya's theory.


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.

Unit 1: Laplace transform—Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Properties of inverse Laplace transform. Convolution theorem. Complex inversion formula.

- Unit 2:** Fourier transform—Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives. Mellin transform—Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem.
- Unit 3:** Infinite Hankel transform—Definition and elementary properties, Hankel transform of derivatives. Inversion theorem. Parseval Theorem. 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.
- Unit 4:** 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. 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.
- Unit 5:** Solution of Volterra integral equations of second kind with convolution type kernels by Laplace transform. Solution of singular integral equations by Fourier transform. 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. Hilbert-Schmidt theorem. Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem. Classical Fredholm theory—Fredholm theorems. Solution of Fredholm integral equation of second kind by using Fredholm first theorem.

~~Paper—XI : General 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: Topological groups, Closed subgroups and the topology on the spaces of right/left cosets. Locally compact group and Compact groups.

Unit 2: Left/right Haar measures on locally Compact groups, Existence and Uniqueness of left/right Haar measure. Unimodularity with a proof that compact groups are unimodular.

Unit 3: Linear lie groups, Coordinate systems for groups like $GL(n, \mathbb{R})$. Lie algebra, Lie algebra of linear groups, Exponential map as a local homomorphism, Closed subgroups of linear Lie groups and their Lie algebras. Lie algebras of some common linear Lie groups.

Unit 4: Differentiable manifolds, Mappings, Submanifolds, Tangent vectors, Tangent and Cotangent spaces.

Unit 5: Tensor algebra, Exterior algebra and Calculus of forms, Connections.

Paper—~~1~~ : 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 transforma-

tion equations, Composition of Parallel velocities, Lorentz-Fitzgerald contraction formula, Time dilation, 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 Echodelay (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.

Paper—XIII : Ring 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.

Unit 1: Basic concepts, Ideals and Homomorphism, Ring of quotients, Prime ideals in commutative ring. Prime ideals and M-system. Radical of a ring, Minimum and Maximum ideal.

Unit 2: Direct and sub-direct sum, Sub-directly irreducible ring, Boolean rings, P-rings, regular rings, Neotherion rings, Primary ideal, their intersection and irredundant representation.

Unit 3: Associated prime-ideals, Ideals and algebraic manifold, Ideal products and the Nilpotent Ideals in complete matrix rings. Semi-prime ideals, Prime radicals of a ring.

Unit 4: Prime ring, Ascending and descending chains, Conditions and prime radical, Endomorphism and linear transformation, Properties of complete matrix.

Unit 5: Rings over an arbitrary division ring, Wedderburn structure theorem, Jacobson's radical and its properties, Idempotent and regular elements of a dense ring, Properties of dense rings.

Paper—~~XIV~~ : 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 1: Partial differential equations and techniques of solution. Finite difference methods for solving PDE. Application to problems of industry with special reference to Fluid Mechanics. Operational techniques.

Unit 2: Linear Programming problems. Computational procedure of Simplex method. Two-phase Simplex method, Big-M-method, Revised Simplex method, Duality in linear programming, Duality and Simplex method.

Unit 3: Assignment models, Mathematical formulation, Hungarian method. Travelling Salesman problem. Transportation models. Mathematical formulation. Initial basic feasible solution. Degeneracy and unbalanced transportation problems.

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 distribute with Monotone failure rate.


Paper—~~11~~: 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 1: Maxwell electromagnetic field equations. Constitutive equations of fluid motion, Stokes hypothesis. Maxwell stress tensor. Fundamental equations of Magnetofluid-dynamics. Magnetofluiddynamic approximations. Magnetic field equations, Frozen in fluid, Alfven transverse waves. MHD bound-

ary conditions. Inspection and Dimensional analysis, π -products.

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 field. Wilson's numerical solution technique.

Unit 4: MHD boundary layer flow past a flat plate in a transverse magnetic field. Modified Rossow's method of solution. MHD plane free jet flow. Wave and theory of characteristics, Equation of the characteristics. Characteristic surfaces. MHD characteristic equations. MHD waves.

Unit 5: Friedriches diagrams. Dispersion relation. MHD shock waves. Generalised Hugoniot condition. Compressive nature of MHD shocks. MHD shock wave classification. MHD shock stability.

Paper—~~XVI~~ XVII : 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 1: Iterative methods — Theory of iteration method, Acceleration of the convergence. Chebyshev method, Muler's method, Methods for multiple and complex roots. Newton-Raphson

method for simultaneous equations, Convergence of iteration process in the case of several unknowns.

Unit 2: Solution of polynomial equations — Polynomial equation, real and complex roots, Synthetic division, the Birge-Vieta, Bairstow and Graeffe's root squaring method. System of simultaneous Equations (Linear)-Direct method, Method of determinant, Gauss-Jordan, LU-Factorizations-Doolittle's Crout's and Cholesky's. Partition method. Method of successive approximate-conjugate gradient and relaxation methods.

Unit 3: Eigen value problems—Basic properties of eigen values and eigen vector, Power methods, Method for finding all eigen values of a matrix, Jacobi, Givens' and Rutishauser method. Complex eigen values.

Curve Fitting and Function Approximations—Least square error criterion. Linear regression. Polynomial fitting and other curve fittings, Approximation of functions by Taylor series and Chebyshev polynomials.

Unit 4: Numerical solution of Ordinary differential Equations—Taylor series Method, Picard method, Runge-Kutta methods upto fourth order, Multistep method (Predictor-corrector strategies), Stability analysis-Single and Multistep 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 $y^{iv} = f(x,y)$.

~~XII~~
XIII

Paper—~~III~~ : Computer Applications

Teaching : 4 Hours per Week

Examination : Only for Regular Candidates

2½ Hrs. duration Theory Paper

Max.Marks 70

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

Unit 1: Introduction to computers, Computer organization, Input-output devices, Memory system, Hardware and Software. Operating system.

Unit 2: Computer languages, System software and application software, Algorithms and flow charts. Programming languages and problem solving on computers.

Unit 3: Programming in C—Constants and variables. Arithmetic expressions, Input-output, Conditional statements, Implementing loops in programmes.

Unit 4: Defining and manipulating arrays, Processing character strings, functions. Files in C. Simple computer programming.

Practical

Teaching : 2 Hours per Week

Examination : 2 Hrs. duration

Max.Marks 30

Simple C Programming of Problems of numerical analysis, Solution of quadratic equations, Mean and standard deviation, Fitting of curves, Correlation coefficient, Applications into matrices, Sorting of numerical character string data etc.

Distribution of Marks :

Two Practical—10 Marks each	= 20 Marks
Practical Record	= 05 Marks
Viva-Voce	= 05 Marks
Total Marks	= 30 Marks

Note :

1. 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.
2. Each candidate has to prepare his/her practical record.
3. Each candidate has to pass in Theory and Practical examinations separately.

**UNIVERSITY OF RAJASTHAN
JAIPUR
RULES FOR THE AWARD OF
GRACEMARKS**

A. UNDER GRADUATE/POST GRADUATE (MAIN/SUPPLEMENTARY) EXAMINATIONS UNDER THE FACULTIES OF ARTS, FINE ARTS, SCIENCE, COMMERCE, SOCIAL SCIENCE, EDUCATION, MANAGEMENT, HOMOEOPATHY, LAW, AYURVEDA AND ENGINEERING & TECHNOLOGY.

Grace marks to the extent of 1% of the aggregate marks prescribed for an examination will be awarded to a candidate failing in not more than 25% of the total number of theory papers, practicals, sessionals, dissertation, viva-voce and the aggregate, as the case may be, in which minimum pass marks have been prescribed; provided the candidate passes the examination by the award of such Grace Marks. For the purpose of determining the number of 25% of the papers, only such theory papers, practicals, dissertation, viva-voce etc. would be considered, of which, the examination is conducted by the University.

N.B. : If 1% of the aggregate marks or 25% of the papers works out in fraction, the same will be raised to the next whole number. For example, if the aggregate marks prescribed for the examination are 450, grace marks to the extent of 5 will be awarded to the candidate, similarly, if 25% of the total papers is 3.2, the same will be raised to 4 papers in which grace marks can be given.

B. DIPLOMA IN PHARMACY, BACHELOR OF PHARMACY, B.Sc. (NURSING) AND B.D.S. EXAMINATIONS

1. A student who obtains the required minimum pass marks in the total aggregate but fails to obtain the minimum pass marks in (i) two subjects, (ii) in one subject and in one practical, or (iii) in two practicals, as the case may be, will be given grace marks according to the following scale, provided the candidate passes the examination by the award of such grace marks.

For 1 to 6 marks above

the min. aggregate : 2 grace marks

For 7 to 12 marks above

the min. aggregate : 3 grace marks

For 14 to 18 marks above

the min. aggregate : 4 grace marks

For 19 and above the min. aggregate : 5 grace marks

- (i) The theoretical and practical tests (wherever held) in a subject will count as 2 subjects.
- (ii) In case it is necessary to secure minimum pass marks in one part of a subject the above rule will be applicable as follows:

“If a candidate fails in the compulsory part of the subjects as well as in the whole subject, he/she will be deemed to have passed in the subject if the greater of the two deficiencies or where the two deficiencies are equal, one of them is covered by the grace marks to which he/she is entitled under the rules.

2. No grace marks would be awarded to a candidate who appears in part/supplementary examination.

C. M.B.B.S. AND B.A.S.L.P. (BACHELOR OF AUDIOLOGY, SPEECH AND LANGUAGE PATHOLOGY) EXAMINATIONS

1. The grace marks upto a maximum of 5 marks will be awarded to a student who has failed only in one subject (Theory and/or practical) but has passed in all other subject.
2. No grace marks would be awarded to a candidate who appears in part/supplementary examination.

General

1. A candidate who passes in a paper/practical or the aggregate by the award of grace marks will be deemed to have obtained the necessary minimum for a pass in that paper/practical or in the aggregate and shown in the marks sheet to have passed by grace. Grace marks will not be added to the marks obtained by a candi-

date from the examiners nor will the marks obtained by the candidate be subject to any deduction due to award of grace marks in any other paper/practical or aggregate.

2. If a candidate passes the examination but misses First or Second Division by one mark, his aggregate will be raised by one mark so as to entitle him for the first or second division, as the case may be. This one mark will be added to the paper in which he gets the least marks and also in the aggregate by showing +1 in the tabulation register below the marks actually obtained by the candidate. The marks entered in the marks-sheet will be inclusive of one grace mark and it will not be shown separately.
3. Non—appearance of a candidate in any paper will make him ineligible for grace marks. The place of a passed candidate in the examination list will, however, be determined by the aggregate marks he secures from the examiners, and he will not, by the award of grace marks, become entitle to a higher division.
4. Distinction won in any subject at the examination is not to be forfeited on the score that a candidate has secured grace marks to pass the examination.

Note: The grace marks will be awarded only if the candidate appears in all the registered papers prescribed for the examination.

