SCHEME OF EXAMINATION

&

DETAILED COURSE STRUCTURE

FOR

MASTER OF SCIENCE/ ARTS (M.Sc. / M.A.)

SUBJECT – MATHEMATICS

(2017-2020)

DEPARTMENT OF MATHEMATICS

S.S. JAIN SUBODH P.G. AUTONOMOUS COLLEGE

RAMBAGH CIRCLE, JAIPUR-302004
S. S. Jain Subodh PG (Autonomous) College, Jaipur  
Department of Mathematics  
Master of Science (M.Sc./ M.A.)

Examination Scheme:

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**Examination Scheme for each Paper**

Part A - comprises of eight very short answer questions from all units. It’s a compulsory question and attempt any seven (Science/Arts) 7X 2 mark each =14 Marks

Part B - 4 questions (1 question from each unit with internal choice) (Science/Arts) 4X14 mark each = 56 Marks

Total of End semester exam (duration of exam 3 hours) =70Marks

Internal assessment = 30Marks
SEMESTER – I

MAT 101: Algebra-I

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit-1
Direct product of groups (External and Internal). Isomorphism theorems – Diamond isomorphism Theorem, Butterfly Lemma, Conjugate classes (Excluding p-groups).

Unit-2
Commutators, Derived subgroups, Normal series and Solvable groups, Composition series, Refinement theorem and Jordan-Holder theorem for infinite groups.

Unit -3
Field theory – Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, Normal extensions. Splitting fields.

Unit -4
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.

MAT 102: Real Analysis

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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 Nonmeasurable sets.

Unit - 2
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**
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.

**Unit - 4**
Summable functions, Space of square summable functions. Fourier series and coefficients, Parseval’s identity, Riesz-Fisher Theorem.

**MAT 103: Differential Equations- I**

**Duration : 3 hrs. Max. Marks: 70**

**Note:** There will be two parts in end semester theory paper.

**Part A-** Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

**Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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.

**Unit - 2**
Total Differential equations. Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.

**Unit - 3**
Series Solution: Radius of convergence, method of differentiation, Cauchy-Euler equation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity.

**Unit - 4**
Partial differential equations of second order with variable co-efficients- Monge’s method.

**MAT 104: Differential Geometry**

**Duration : 3 hrs. Max. Marks: 70**

**Note:** There will be two parts in end semester theory paper.
Part A - Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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 and Evolutes.

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

Unit - 3
Normal curvature. Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussian curvature, Radius of curvature of a given section through any point on $z = f(x, y)$. Lines of curvature, Principal radii, Relation between fundamental forms.

Unit - 4
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.

MAT 105: Dynamics of Rigid Bodies

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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.

Unit - 2
The compound pendulum, Centre of percussion.Motion of a rigid body in two dimensions under finite and impulsive forces.

**Unit - 3**
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).

**Unit - 4**
Lagrange’s equations for holonomous dynamical system, Energy equation for conservative field, Small oscillations, Motion of a top, Hamilton’s equations of motion, Hamilton’s principle and principle of least action.

**MAT 106: Calculus of Variation and Special Function-I**

**Duration : 3 hrs. Max. Marks: 70**
**Note: There will be two parts in end semester theory paper.**

**Part A - Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.**

**Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.**

**Unit - 1**
Calculus of variation – Functionals, Variation of a functional and its properties,Variational problems with fixed boundaries, Euler’s equation, Extremals, Functional dependent onseveral unknown functions and their first order derivatives. (Variational Problems with fixed boundaries)

**Unit - 2**
Functionals dependent on higher order derivatives, Functionals dependent on the function ofmore than one independent variable.Variational problems in parametric form. (Variational Problems with fixed boundaries)

**Unit - 3**
Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguousfunction 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 - 4**
Legendre polynomials and Series Solution of Legendre’s equation and functions \( P_n(x) \) and \( Q_n(x) \).
Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1
Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dualmaps, Annihilator.

Unit - 2
Matrices of a linear maps, Matrices of composition maps, Matrices of dual map, Eigenvalues, Eigen vectors, Rank and Nullity of linear maps and matrices, Invertible matrices, Similar matrices.

Unit - 3
Determinants of matrices and its computations, Characteristic polynomial and eigenvalues. Real inner product space, Schwartzs inequality.

Unit - 4
Orthogonality, Bessel’s inequality, Adjoint, Self adjoint linear transformations and matrices, Orthogonal linear transformation and matrices, Principal Axis Theorem

MAT 202: Topology
Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1
Topological spaces, Subspaces, Open sets, Closed sets, Neighbourhood system, Bases and sub-bases.

Unit – 2
Continuous mapping and Homeomorphism, Nets, Filters.

Unit - 3
Separation axioms (To, T1, T2, T3, T4). Compact and locally compact spaces. Continuity and Compactness.

**Unit - 4**

**MAT 203: Differential Equation-II**

*Duration: 3 hrs. Max. Marks: 70*

*Note: There will be two parts in end semester theory paper.*

**Part A**
Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carry 2 marks.

**Part B**
The paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

**Unit - 1**
Classification of linear partial differential equation of second order, Canonical forms, Cauchy’s problem of first and second order partial differential equation.

**Unit - 2**
Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange’s identity, properties of Eigen functions, important theorems of sturm Liouville system, Periodic functions.

**Unit - 3**

**Unit - 4**
Green’s Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green’s function), Procedure of constructing the Green’s function and solution of boundary value problem, properties of Green’s function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green’s function, Modified Green’s function.

**MAT 204: Riemannian Geometry and Tensor Analysis**

*Duration: 3 hrs. Max. Marks: 70*

*Note: There will be two parts in end semester theory paper.*

**Part A**
Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1
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.

Unit - 2

Unit - 3
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.

Unit - 4

MAT 205: Hydrodynamics

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1

Unit - 2
Stream-lines, path-lines and streak lines, velocity potential, irrotational motion.

Unit - 3

Unit - 4
Motion due to impulsive forces. Motion in two-dimensions, Stream function, Complex potential. Sources, Sinks, Doublets, Images in two-dimensions.
MAT 206 : Special Functions- II

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1
Bessel functions Jn(x).

Unit - 2
Hermite polynomials Hn(x), Laguerre and Associated Laguerre polynomials.

Unit - 3
Jacobi Polynomial: Definition and its special cases, Bateman’s generating function, Rodrigue’s formula, orthogonality, recurrence relations, expansion in series of polynomials.

Unit - 4
Chebyshev polynomials Tn(x) and Un(x): Definition, Solutions of Chebyshev’s equation, expansions, Generating functions, Recurrence relations, Orthogonality.
SEMESTER - III
MAT 301: Functional Analysis- I

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit 1:

Unit – 2

Unit - 3

Unit – 4

MAT 302: Viscous Fluid Dynamics-I

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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.
Unit – 2
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 – 3
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.

Unit – 4
Flow between two concentric rotating cylinders. Stagnation point flows: Hiemenz flow, Homann flow. Flow due to a rotating disc.

MAT C01: Mathematical Programming –I

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit – 1
Separating and supporting hyperplane theorems. Revised simplex method to solve Linear Programming problems, Bounded variable problems.

Unit – 2
Integer programming: Gomory’s algorithm for all and mixed integer programming problems, Branch and Bound algorithm; Goal programming: Graphical goal attainment method, Simplex method for GPP.

Unit – 3

Unit - 4
MAT E01: Integral Transforms

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.
Unit – 1
Unit – 2
Unit - 3
Unit – 4

MAT F01: Relativistic Mechanics

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 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 dilation.
Unit – 2
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 - 3
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.

Unit - 4

MAT G01: Numerical Analysis – I

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit – 1

Unit - 2
Newton-Raphson method for simultaneous equations, Convergence of iteration process in the case of several unknowns. Solution of polynomial equations – Polynomial equation, Real and complex roots, Synthetic division, the Birge-Vieta, Bairstow and Graeffe’s root squaring method.

Unit - 3
System of simultaneous Equations (Linear)- Direct method, Method of determinant, Gauss- Jordan, LU-Factorizations-Doolitte’s, Crout’s and Cholesky’s. Partition method. Relaxation methods.

Unit - 4
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.
SEMESTER – IV

MAT 401: Functional Analysis II and Advanced Calculus

Duration: 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A: Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.
Unit – 1
Unit – 2
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 - 3
Unit – 4
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.

MAT 402: Viscous Fluid Dynamics – II

Duration: 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A: Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.
Unit – 1
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 - 2
Equation of energy, Temperature distribution: Between parallel plates, in a pipe, between two concentric rotating cylinders.

**Unit - 3**
Variable viscosity plane Couette flow, temperature distribution of plane Couette flow with transpiration cooling. Theory of very slow motion: Stokes’ and Oseen’s flows past a sphere.

**Unit – 4**
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

**MAT C02: Mathematical Programming – II**

**Duration:** 3 hrs. **Max. Marks:** 70

**Note:** There will be two parts in end semester theory paper.

**Part A** - Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

**Part B** of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

**Unit – 1**
Convex function, Quadratic forms, constrained problem of maxima and minima, Lagrangian method, Non-linear programming: Formulation and Graphical method.

**Unit – 2**
Non-linear programming and its fundamental ingredients, Khun-Tucker necessary and sufficient conditions; Saddle point, Saddle-point theorems.

**Unit – 3**
Quadratic Programming: Kuhn-Tueker conditions, Wolfe method, Duality in Quadratic Programming.

**Unit - 4**
Beals method to solve QPP, Geometric Programming: Formulation, geometric arithmetic inequality, necessary conditions of optimality.

**MAT E02: Integral Equations**

**Duration:** 3 hrs. **Max. Marks:** 70

**Note:** There will be two parts in end semester theory paper.

**Part A** - Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

**Part B** of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.
Unit – 1

Unit - 2

Unit – 3

Unit - 4

MAT F02: General Relativity & Cosmology

Duration : 3 hrs. Max. Marks: 70
Note: There will be two parts in end semester theory paper.
Part A- Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.
Part B of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

Unit - 1
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, Removal of clock paradox in General Relativity.

Unit - 2
Schwarzschild exterior metric, its isotropic form, Singularity and singularities in Schwarzschild exterior metric. Derivation of the formula GM = c²m, Mass of sun in gravitational unit, Relativistic differential equation for the orbit of the planet.

Unit – 3
Three crucial tests in General Relativity and their detailed descriptions, Analogues of Kepler’s laws in General Relativity, Trace of Einstein tensor, Energy-
momentum tensor and its expression for perfect fluid, Schwarzschild interior metric and boundary condition.

**Unit – 4**
Lorentz invariance of Maxwell’s equations in empty space, Lorentz force on charged particle, Energymomentum tensor for electro-magnetic field. Einstein’s field equation with cosmological term, Static cosmological models (Einstein & de-Sitter models) with physical and geometrical properties, Nonstatic form of de-Sitter line-element and Red shift in this metric, Einstein space, Hubble’s law, Weyl’s postulate.

**MAT G02: Numerical Analysis – II**

**Duration : 3 hrs. Max. Marks: 70**

**Note:** There will be two parts in end semester theory paper.

**Part A** - Question 1 is compulsory comprises eight very short answer questions (Two from each Unit). Candidate has to attempt any seven questions. Each question carries 2 marks.

**Part B** of the paper will consist four questions one question from each unit with internal choice. Each question will carry 14 marks.

**Unit – 1**
Curve Fitting and Function Approximations – Least square error criterion. Linear regression. Polynomial fitting and other curve fittings, Approximation of functions by Taylor series and Chebychev polynomials.

**Unit – 2**

**Unit - 3**
Stability analysis – Single and Multistep methods. BVP’s of ordinary differential Equations – Boundary value problems (BVP’s), Shooting methods.

**Unit - 4**
Finite difference methods. Difference schemes for linear boundary value problems of the type $y'' =f(x, y), y'' =f(x, y, y')$ and $y'' =f(x, y)$. 