UNIVERSITY OF RAJASTHAN, JAIPUR

M.A./M.SC./~~M.COM~~

(MATHEMATICS)

2013-2014 (PREVIOUS)-I/II SEMESTER

2014-2015 (FINAL)- III/IV SEMESTER

Prepared by

Checked by

MA/MSc. Mathematics 2013-2015

C	2.50 to 3.49	0.1
D	1.50 to 2.49	0.12
E	0.50 to 1.49	0.08
F	0.00 to 0.49	0.5

For example (i) CGPA of 5.73 is equivalent to 86.5%, (ii) CGPA of 5.12 is equivalent to 71.2%, (iii) CGPA of 4.34 is equivalent to 63.4%, (iv) CGPA of 3.26 is equivalent to 52.6%, (v) CGPA of 2.17 is equivalent to 41.04%, and (vi) CGPA of 1.11 is equivalent to 29.88%.

2. **Eligibility:**

A candidate who has secured more than 50% or CGPA of 3.0 in the UGC Seven Point scale [45% or CGPA 2.5 in the UGC Seven Point Scale for SC/ST/Non-creamy layer OBC] or equivalent in the Bachelor degree in Science or Engineering or Technology or Medicine or Pharmaceutical Science shall be eligible for admission to First Semester of a Master of Science course.

3. **Scheme of Examination:**

(1) Each theory paper EoSE shall carry 100 marks The EoSE will be of 3 hours duration. Part 'A' of theory paper shall contain 10 Short Answer Questions of 20 marks, based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry two mark for correct answer.

(2) Part "B" of paper will consisting of Four questions with internal choice (except in cases where a different scheme is specifically specified in the syllabus of 20 mark each. The limit of answer will be five pages.

Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

Each 20

(3) Each Laboratory EoSE will be of four/six hour durations and involve laboratory experiments/exercises, and viva-voce examination with weightage in ratio of 75:25.

4. Course Structure:

The details of the courses with code, title and the credits assign are as given below.

Abbreviations Used

Course Category

CCC: Compulsory Core Course
ECC: Elective Core Course
OEC: Open Elective Course

SC: Supportive Course
SSC: Self Study Core Course
SEM: Seminar
PRJ: Project Work
RP: Research Publication

Contact Hours

L: Lecture
T: Tutorial
P: Practical or Other
S: Self Study

Relative Weights

IA: Internal Assessment (Attendance/Classroom Participation/Quiz/Home Assignment etc.)
ST: Sessional Test
EoSE: End of Semester Examination

First Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
1.	MAT 101	Algebra-I	CCC	6	6	0	0	3	0
2.	MAT 102	Real Analysis	CCC	6	6	0	0	3	0
3.	MAT 103	Differential Equations-I	CCC	6	6	0	0	3	0
4.	MAT 104	Differential Geometry	CCC	6	6	0	0	3	0
5.	MAT 105	Dynamics of Rigid Bodies	CCC	6	6	0	0	3	0
6.	MAT 106	Calculus of Variation and Special Function-I	CCC	6	6	0	0	3	0

Second Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
1.	MAT 201	Algebra-II	CCC	6	6	0	0	3	0
2.	MAT 202	Topology	CCC	6	6	0	0	3	0
3.	MAT 203	Differential Equations-II	CCC	6	6	0	0	3	0
4.	MAT 204	Riemannian Geometry and Tensor Analysis	CCC	6	6	0	0	3	0
5.	MAT 205	Hydrodynamics	CCC	6	6	0	0	3	0
6.	MAT 206	Special Functions-II	CCC	6	6	0	0	3	0

EoSE : End of Semester Examination

Third Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
1.	MAT 301	Functional Analysis-I	CCC	6	6	0	0	3	0
2.	MAT 302	Viscous Fluid Dynamics-I	CCC	6	6	0	0	3	0
		Core-Elective- I	ECC	6	6	0	0	3	0
		Core-Elective-II	ECC	6	6	0	0	3	0
		Core-Elective-III	ECC	6	6	0	0	3	0
		Core Elective-IV	ECC	6	6	0	0	3	0

Candidates are required to opt any four elective core courses (6 credits each) from MAT A01, MAT B01, MAT C01, MAT D01, MAT E01, MAT F01. MAT G01, MAT H01, MAT I01, MAT J01.

Fourth Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
1.	MAT 401	Functional Analysis-II	CCC	6	6	0	0	3	0
2.	MAT 402	Viscous Fluid Dynamics-II	CCC	6	6	0	0	3	0
		Core-Elective- V	ECC	6	6	0	0	3	0
		Core-Elective- VI	ECC	6	6	0	0	3	0
		Core-Elective- VII	ECC	6	6	0	0	3	0
		Core-Elective- VIII	ECC	6	6*	0	0*	3*	0*

Candidates are required to opt the corresponding four elective core courses of same specialization cluster obtained in Semester Third (6 credits each) from MAT A02, MAT B02, MAT C02, MAT D02, MAT E02, MAT F02. MAT G02, MAT H02, MAT I02, MAT J11.

* **L=0,P=9 EoSE:- THY=0, P=4 FOR MAT J11**

Elective Core Courses

Specialization Clusters

A. CM Continuum Mechanics

B. BLT Boundary Layer Theory

C. MP Mathematical Programming

D. CGT Combinatorics and Graph Theory

E. ITE Integral Transforms and Integral Equations

F. RC Relativity and Cosmology

G. IM Industrial Mathematics

H. MHD Magnetohydrodynamics

I. NA Numerical Analysis

J. CA Computer Applications

Elective Course	Specialization	Paper	Prerequisite	Semester
MAT A01	CM	Continuum Mechanics-I	-	
MAT A02	CM	Continuum Mechanics-II	MAT A01	
MAT B01	BLT	Boundary Layer Theory-I	-	
MAT B02	BLT	Boundary Layer Theory-II	MAT B01	
MAT C01	MP	Mathematical Progamming-I	-	
MAT C02	MP	Mathematical Programming-II	MAT C01	
MAT D01	CGT	Combinatorics and Graph Theory-I	-	
MAT D02	CGT	Graph Theory-II	MAT D01	
MAT E01	ITE	Integral Transforms	-	
MAT E02	ITE	Integral Equations	MAT E01	
MAT F01	RC	Relativistic Mechanics	-	
MAT F02	RC	General Relativity and Cosmology	MAT F01	
MAT G01	IM	Industrial Mathematics-I	-	
MAT G02	IM	Industrial Mathematics-II	MAT G01	
MAT H01	MHD	Magnetohydrodynamics-I	-	
MAT H02	MHD	Magnetohydrodynamics-II	MAT H01	
MAT I01	NA	Numerical Analysis-I	-	
MAT I02	NA	Numerical Analysis-II	MAT I01	
MAT J01	CA	Computer Applications-Theory	-	
MAT J11	CA	Computer Applications-Practical	MAT J01	

MAT 101: Algebra-I

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

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.

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

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

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, Developable surface, 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. Pricipal directions and Principal curvatures, First curvature, Mean curvature, Gaussion 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

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, Hemilton's equations of motion, Hamilton's principle and principle of least action.

MAT 106: Calculus of Variation and Special Function-I

Unit - 1

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.

Unit - 2

Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form.

Unit - 3

Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its properties, Integral representation, Kummer's first transformation and series solution of Legendre's equation.

Unit - 4

Legendre polynomials and functions $P_n(x)$ and $Q_n(x)$.

MAT 201: Algebra II

Unit - 1

Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dual maps, Annihilator.

Unit - 2

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.

Unit - 3

Determinants of matrices and its computations, Characteristic polynomial and eigen values.Real inner product space, Schwartzs inequality.

Unit - 4

Orthogonality, Bessel's inequality, Adjoint, Self adjoint linear transformations and matrices, Othogonal linear transformation and matrices, Principal Axis Theorem.

MAT 202: Topology

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, T_1, T_2, T_3, T_4). Compact and locally compact spaces. Continuity and Compactness.

Unit - 4

Product and Quotient spaces. Tychonoff's one point compactification. Connected and Locally connected spaces, Continuity and Connectedness.

MAT 203: Differential Equation-II

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

Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigen function expansion). Method of separation of variables, Laplace, wave and diffusion equations.

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

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

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 - 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

Reimann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.

MAT 205: Hydrodynamics

Unit - 1

Kinematics of ideal fluid. Lagrange's and Euler's methods. Equation of continuity in Cartesian, cylindrical and spherical polar coordinates. Boundary surface.

Unit - 2

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

Unit - 3

Euler's hydrodynamic equations. Bernoulli's theorem. Helmholtz equations. Cauchy's integral.

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

Unit - 1

Bessel functions $J_n(x)$.

Unit - 2

Hermite polynomials $H_n(x)$, 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 $T_n(x)$ and $U_n(x)$: Definition, Solutions of Chebyshev's equation, expansions, Generating functions, Recurrence relations, Orthogonality.

MAT 301: Functional Analysis- I

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.

Unit – 2

Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem.

Unit - 3

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 – 4

Orthogonality and Functionals in Hilbert Spaces. Phythagorean 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.

MAT 302: Viscous Fluid Dynamics-I

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 401: Functional Analysis II and Advanced Calculus

Unit – 1

Adjoint of an operator on a Hilbert space. Self-adjoint, Positive, Normal and Unitary operators and their properties.Projection on a Hilbert space. Invariance. Reducibility. Orthogonal projections.

Unit – 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

Partial derivatives and Jacobian Matrix. Continuously differentiable maps. Higher derivatives. Taylor's formula.

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

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 A01: Continuum Mechanics – I

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.

Unit – 4

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.

MAT A02: Continuum Mechanics – II

Unit – 1

Law of conservation of mass and Eulerian continuity equation. Reynolds transport theorem. Momentum integral theorem and equation of motion.

Unit – 2

Kinetic equation of state. First and the second law of thermodynamics and dissipation function. Applications (Linear elasticity and Fluids) – Assumptions and basic equations. Generalized Hook's law for an isotropic homogeneous solid.

Unit – 3

Compatibility equations (Beltrami-Michell equations). Classification of types of problems in linear elasticity. Principle of superposition, Strain energy function, Uniqueness theorem, p-ρ relationship and work kinetic energy equation, Irrotational flow and Velocity potential.

Unit – 4

Kinetic equation of state and first law of Thermodynamics. Equation of continuity. Equations of motion. Vorticity-stream surfaces for inviscid flow, Bernoullis equations. Irrotational flow and velocity potential. Similarity parameters of fluid flow.

MAT B01: Boundary Layer Theory- I

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.

Unit - 2

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.

Unit-3

Flow past a symmetrically placed cylinder (Blasius series solution). Gortler new series method. Plane free jet, Circular jet, Plane wall jet. Prandtl-Mises transformation and its application of plane free jet.

Unit - 4

Axially symmetrical boundary layers on bodies at rest. Boundary layers on a body of revolution. Mangler's transformation. Three-dimensional boundary layers – Boundary layer flow on yawed cylinder. Growth of three-dimensional boundary layer on a rotating disc impulsively set in motion.

MAT B02: Boundary Layer Theory – II

Unit-1

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 - 2

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.

Unit - 3

Derivation of two-dimensional thermal boundary layer equation for flow over a plane wall. Forced convection in a laminar boundary layer on a flat plate, Crocco's first and second integrals. Reynolds analogy.

Unit - 4

Temprature 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 Pohlhausan's problem of free convection from a heated vertical plate.

MAT C01: Mathematical Programming -I

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

Separable programming: Piece-wise Linear approximations to non-linear functions, Reduction to separable programming problem to l.p.p., separable programming algorithm, fractional programming: computational procedure.

Unit - 4

Dynamic programming: Introduction, Bellman principle of optimality, solution of problems with finite number stages, solution of l.p.p. by dynamic programming.

MAT C02: Mathematical Programming - II

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 ingradients, 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 D01: Combinatorics and Graph Theory- I

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

Unit - 4

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

MAT D02: Graph Theory – II

Unit - 1

Cut sets– Cut-sets, Cut vertices. Fundamental cut sets, Connectivity and seperativity. Net work flows, Max-flow min-cut theorem.

Unit - 2

Plannar Graphs-- Combinatorial and geometric graphs, Kuratowski's graphs. Euler's formula. Detection of planarity. Geometric dual. Thickness and Crossing number.

Unit - 3

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

Unit - 4

Digraphs– binary relations, Directed graphs and Directed trees, Arborescence, Polish notation method, Tournaments. Counting of Labeled Trees– Cayley's theorem. Counting methods, Polya's theory.

MAT E01: Integral Transforms

Unit – 1

Fourier transform – Defiition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.

Unit – 2

Mellin transform– Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem.

Unit - 3

Laplace transform– Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Properties of inverse Laplace transform. Convolution theorem.

Unit – 4

Complex inversion formula. Infinite Hankel transform– Definition and elementary properties. Hankel transform of derivatives. Inversion theorem. Parseval Theorem.

MAT E02: Integral Equations

Unit – 1

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

Unit - 2

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 – 3

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.

Unit - 4

Solution of Volterra integral equations of second kind with convolution type kernels by Laplace transform. Solution of singular integral equations by Fourier transform.

Classical Fredholm theory– Fredholm theorems. Solution of Fredholm integral equation of second kind by using Fredholm first theorem.

MAT F01: Relativistic Mechanics

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

Minkowski space, Space-like, Time-like and Light-like intervals, Null cone, Relativity and Causality, Proper time, World line of a particle. Principles of Equivalence and General Covariance.

MAT F02: General Relativity & Cosmology

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 $GM = c^2m$, 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, Energy-momentum tensor for electro-magnetic field. Einstein's field equation with cosmological term, Static cosmological models (Einstein & de-Sitter models) with physical and geometrical properties, Non-

static form of de-Sitter line-element and Red shift in this metric, Einstein space, Hubble's law, Weyl's postulate.

MAT G01: Industrial Mathematics- I

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.

Unit -2

Operational Techniques.Linear Programming problems. Computational procedure of Simplex method, Two-phase Simplex method, Big-M-method.

Unit - 3

Revised Simplex method, Duality in linear programming, Duality and Simplex method.

Unit - 4

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

MAT G02: Industrial Mathematics – II

Unit – 1

Inventory Models. EOQ models with and without shortages.

Unit - 2

EOQ models with constraints.

Unit - 3

Replacement and Reliability models. Replacement of items that deteriorate, Replacement of items that fail completely.

Unit - 4

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.

MAT H01: Magnetohydrodynamics - I

Unit -1

Maxwell electromagnetic field equations. Constitutive equations of fluid motion, Stokes hypothesis. Maxwell stress tensor. Fundamental equations of Magnetofluid-dynamics.

Unit - 2

Magnetofluiddynamic approximations. Magnetic field equation, Frozen in fluid, Alfven transverse waves. MHD boundary conditions.

Unit - 3

Inspection and Dimensional analysis, π-products. Reynolds number, Mach number, Prandtl number, Magnetic Reynolds number, Magnetic pressure number, Hartmann number, Magnetic parameter, Magnetic Prandtl number and Nusselt number.

Unit - 4

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.

MAT H02: Magnetohydrodynamics - II

Unit - 1

MHD flow near a stagnation point. MHD Reyleigh's flow. MHD Stoke's flow past a sphere, MHD Oseen's flow past a sphere.

Unit - 2

MHD boundary layer flow past a flat plate in an aligned magnetic flow. Wilson's numerical solution technique. MHD boundary layer flow past a flat plate in a transverse magnetic field. modified Rossow's method of solution.

Unit - 3

MHD plane free jet flow. Wave and theory of characteristics, Equation of the characteristics, Characteristic surfaces, MHD characteristic equations. MHD waves.

Unit - 4

Friedriches diagrams. Dispersion relation. MHD shock waves. Generalized Hugoniot condition. Compressive nature of MHD shocks. MHD shock wave classification. MHD shock stability.

MAT I01: Numerical Analysis – I

Unit – 1

Iterative methods – Theory of iteration method, Acceleration of the convergence, Chebyshev method, Muler's method, Methods for multiple and complex roots.

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.

MAT I02: Numerical Analysis – II

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 Chebyshev polynomials.

Unit – 2

Numerical solution of Ordinary differential Equations – Taylor series Mathod, Picard method, Runge-Kutta methods upto fourth order, Multistep method (Predictor-corrector strategies).

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 $y^{iv} = f(x,y)$.

MAT J01: Computer Applications- Theory

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. Windows: Graphicala 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. Introduction to MS Word and Ms-Excel. 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 programs.

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

MAT J11: Computer Applications- Practical

Exercises shall be assigned on the topics covered in units 1 to 4 of MAT J01.

There shall be five practicals with internal choice and candidates are required to attempt all five practicals

Installation window XP. 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.