University of Rajasthan
Jaipur

SYLLABUS

M.Sc.

(MATHEMATICS)

2014-2015 (I & II SEMESTER)

2015-2016 (III & IV SEMESTER)

APPENDIX IX AND X

SYLLABUS

SCHEME OF EXAMINATION AND COURSE OF STUDY

FACULTY OF SCIENCE

M.A./M.Sc. MATHEMATICS (SEMESTER SCHEME)

2014-2015 & 2015-2016

First Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 101	Algebra-I	CCC	6	6	3
2.	MAT 102	Real Analysis	CCC	6	6	3
3.	MAT 103	Differential Equations-I	CCC	6	6	3
4.	MAT 104	Differential Geometry	CCC	6	6	3
5.	MAT 105	Dynamics of Rigid Bodies	CCC	6	6	3
6.	MAT 106	Calculus of Variation and Special Function-I	CCC	6	6	3
		Total Credits in the Semester		36		

Second Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 201	Algebra-II	CCC	6	6	3
2.	MAT 202	Topology	CCC	6	6	3
3.	MAT 203	Differential Equations-II	CCC	6	6	3
4.	MAT 204	Riemannian Geometry and Tensor Analysis	CCC	6	6	3
5.	MAT 205	Hydrodynamics	CCC	6	6	3
6.	MAT 206	Special Functions-II	CCC	6	6	3
		Total Credits in the Semester		36		

EoSE : End of Semester Examination

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	Credit
MAT A01	CM	Continuum Mechanics-I	-	6
MAT A02	CM	Continuum Mechanics-II	MAT A01	6
MAT B01	BLT	Boundary Layer Theory-I	-	6
MAT B02	BLT	Boundary Layer Theory-II	MAT B01	6
MAT C01	MP	Mathematical Progamming-I	-	6
MAT C02	MP	Mathematical Programming-II	MAT C01	6
MAT D01	CGT	Combinatorics and Graph Theory-I	-	6
MAT D02	CGT	Graph Theory-II	MAT D01	6
MAT E01	ITE	Integral Transforms	-	6
MAT E02	ITE	Integral Equations	MAT E01	6
MAT F01	RC	Relativistic Mechanics	-	6
MAT F02	RC	General Relativity and Cosmology	MAT F01	6
MAT G01	IM	Industrial Mathematics-I	-	6
MAT G02	IM	Industrial Mathematics-II	MAT G01	6
MAT H01	MHD	Magnetohydrodynamics-I	-	6
MAT H02	MHD	Magnetohydrodynamics-II	MAT H01	6
MAT I01	NA	Numerical Analysis-I	-	6
MAT I02	NA	Numerical Analysis-II	MAT I01	6
MAT J01	CA	Computer Applications-Theory	-	6
MAT J11	CA	Computer Applications-Practical	MAT J01	6

Third Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 301	Functional Analysis-I	CCC	6	6	3
2.	MAT 302	Viscous Fluid Dynamics-I	CCC	6	6	3

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.

Total Credits in the Semester 36

Fourth Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 401	Functional Analysis-II	CCC	6	6	3
2.	MAT 402	Viscous Fluid Dynamics-II	CCC	6	6	3

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.

Total Credits in the Semester 36

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Appendix - IX

MA/M.Sc. Semester Mathematics Examination 2014-2015
Scheme of Examination
Semester System

Semester – I

Note: 1. All Six Papers in Semester I are compulsory (CCC).
2. Continuous assessment (internal) will be done by teacher concerned on the basis of test papers, regularity in the class and performance of the candidate. Maximum marks in continuous assessment of each paper is 30.

Paper- 1: MAT 101 : Algebra-I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 2 : MAT 102 : Real Analysis
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

Uuit - 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.

Paper – 3 : MAT 103 : Differential Equations- I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper- 4 : MAT 104 : Differential Geometry
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

Unit - 1

Conoids, Inflexional tangents, Singular points, Indicatrix. Space curves, Tangent, Contact of curve and surface, Osculating plane, Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Existence and Uniqueness theorem for space curves. Bertrand curves, Involute and Evolutes.

Unit - 2

Envelope of one and two parameters family of surfaces, Ruled surface, Developable surface, Tangent plane to a ruled surface, skew surface-parameter of distrirbution. 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.

Paper- 5 : MAT 105: Dynamics of Rigid Bodies
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Unit - 2

Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum (linear and angular).

Unit - 3

Lagrange's equations for holonomous dynamical system, Energy equation for conservative field, Small oscillations, Hemilton's equations of motion, Hamilton's principle and principle of least action.

Unit - 4

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

Paper – 6 : MAT 106: Calculus of Variation and Special Function-I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the

subpart will carry 2 marks. 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.

Unit - 1

Calculus of variation – Functionals, Variation of a functional and its properties, Variational problems with fixed boundaries, Extremals, Functional dependent on one unknown function and its first order derivative, Euler's equation, Functional dependent on several unknown functions and their first order derivatives.

Unit - 2

Differential of a function and variation of a functional, Geodesic Problems, Variational problems with moving boundaries, Variational problems involving several dependent variables and with moving boundaries, Application of calculus of variation to problems and mechanics.

Unit - 3

Series solution of Gauss hypergeometric equation. Gauss hypergeometric function and its properties, 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.

Unit - 4

Series solution of Legendre's differential equation, Legendre polynomials $P_n(x)$ and Legendre functions $Q_n(x)$.

Semester – II

Note: 1. All six papers in Semester II are compulsory. (CCC)
2. Continuous assessment (internal) will be done by teacher concerned on the basis of test papers, regularity in the class and performance of the candidate. Maximum marks in continuous assessment of each paper is 30.

Paper- 1 : MAT 201 : Algebra II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 2 : MAT 202 : Topology
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper 3 : MAT 203: Differential Equation-II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 4 : MAT 204 : Riemannian Geometry and Tensor Analysis
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

Unit - 1

Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic curvature and torsion, Normal angle, Gauss-Bonnet Theorem.

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.

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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.

Paper – 5 : MAT 205: Hydrodynamics
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

Unit - 1

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 streak lines, velocity potential, irrotational motion.

Unit – 2

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

Unit - 3

Motion due to impulsive forces. Motion in two-dimensions, Stream function, Complex potential. Sources, Sinks, Doublets, Images in two-dimensions.

Unit – 4

Vortex motion Definition, rectilinear vortices, centre of vortices, properties of vortex tube, Two vortex filaments, vortex pair, vortex doublet, vortex inside and outside circular cylinder, Four vortices, motion of the vortex situated at the origin and stream lines.

Paper-6 : MAT 206 : Special Functions- II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Appendix – X

M.A./M.Sc. Semester Mathematics 2015-2016
Semester Scheme (Semester III and IV)

Semester - III

Note: (i) Paper MAT 301 and MAT 302are compulsory (CCC) in Semester III.

(ii) 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.

(iii) Continuous assessment (intenal) will be done by teacher concerned on the basis of test papers,regularity in the class and performance of the candidate Maximum marks in continuous assessment of each paper is 30.

Compulsory Papers (CCC)

Paper- 1 : MAT 301 : Functional Analysis- I

Teaching 6 hours per week. (6 credits)

Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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

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identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.

Paper-2 : MAT 302 : Viscous Fluid Dynamics-I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Optional Papers: (ECC)

Paper – 3 : MAT A01 : Continuum Mechanics – I
Teaching 6 hours per week. (6 credits)
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

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Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 4 : MAT B01 : Boundary Layer Theory- I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper-5: MAT C01 : Mathematical Programming -I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 6: MAT D01 : Combinatorics and Graph Theory- I

Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 7 : MAT E01 : Integral Transforms
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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 theorem. Inverse Laplace transform using complex inversion theorem.. Infinite Hankel transform– Definition and elementary properties. Hankel transform of derivatives. Inversion theorem. Parseval Theorem.

Paper – 8 : MAT F01 : Relativistic Mechanics

Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 9 : MAT G01: Industrial Mathematics- I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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. Computational procedure of Simplex method, Two-phase Simplex method, Duality, .Dual simplex method.

Unit - 3

Revised Simplex method, Sensitivity Analysis in Linear Programming.

Unit - 4

Various Models of Assignment Problems. Alternate Optimal Solutions, Travelling salesman problem. Transportation Models, Post optimality Analysis in Transportation.

Paper – 10: MAT H01: Magnetohydrodynamics - I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

(22)

Paper – 11 : MAT I01 : Numerical Analysis – I
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 12: MAT J01: Computer Applications- Theory
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

Unit – 1

Computer languages, System software and application software. Windows: Graphical user interface, control panel and all features there in files and folders management. Using Accessories, Getting help, copying, moving and sharing information between programs. Setting up printer and fonts. Configuring modem. Introduction to MS Word and Ms-Excel. Algorithms and flow charts. Programming languages and problem solving on computers.

Unit 2:

Programming in C++ Constants and variables. Arithmetic expressions, Input-output, Conditional statements, Implementing loops in programs.

Unit 3

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

Unit 4

Programming using Matlab/Mathematica – Variables, Vector and Matrix Computation, Built-in-functions, Plotting, output, M-files, Functions, Loops, Conditional Execution, Matrix Multiplication.

Semester – IV

Note: (i) Paper MAT 401 and MAT 402are compulsory in Semester IV.

(ii) 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.

(iii) Continuous assessment (intenal) will be done by teacher concerned on the basis of test papers, regularity in the class and performance of the candidate Maximum marks in continuous assessment of each paper is 30.

Paper -1 : MAT 401 : Functional Analysis II and Advanced Calculus

Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 2: MAT 402 : Viscous Fluid Dynamics – II

Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Optional Paper (ECC)
Paper – 3 : MAT A02 : Continuum Mechanics – II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 4 : MAT B02 : Boundary Layer Theory – II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 5 : MAT C02 : Mathematical Programming - II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 6 : MAT D02: Graph Theory – II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 7: MAT E02 : Integral Equations
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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 results related to it. 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 terms of eigen functions and bilinear form. Hilbert-Schmidt theorem. Solution of Fredholm integral equations of second kind using Hilbert-Schmidt theorem.

Unit - 4

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

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

Paper – 8 : MAT F02 : General Relativity & Cosmology
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 9 : MAT G02 : Industrial Mathematics – II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper – 10 : MAT H02: Magnetohydrodynamics - II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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.

Paper 11 : MAT I02 : Numerical Analysis – II
Teaching 6 hours per week. (6 credits)
Examination 3 hrs. duration Theory Paper Max.Marks-100

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in question paper. Part 'A' of the question paper shall contain first question with 10 subparts consisting of very short answer type questions based on knowledge, understanding and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. 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.

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

Paper – 12: MAT J 11: Computer Applications- Practical Using Matlab/ Mathematica
Teaching: 9 Hours per Week. (Six credits)
Examination 4 Hrs.duration Practical Paper Max.Marks 100

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

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

Solution of linear systems – Gauss elimination, Gauss-Seidel, Eigenvalues and Eigenvectors – Power method and inverse power method. Least Squares Approximation – Fitting of straight line, parabola and cubic equation. Numerical integration – Traapezoidal and Simpson's methods, Numerical solution of differential equation – Euler's method, Fourth order Runge-Kutta method.

Distribution of Marks:

Five Practicals – 15 Marks each	= 75 Marks
Practical Record	= 10 Marks
Viva-Voce	= 15 Marks
Total Marks	= 100 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.