UNIVERSITY OF RAJASTHAN

JAIPUR

SYLLABUS

M.A/M.SC. MATHEMATICS

Semester Scheme

I/II Semester Examination 2018-19

III/IV Semester Examination 2019-20

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University of Rajasthan, Jaipur

M.A./M.Sc. Syllabus in Mathematics as per new scheme: credit-based Semester System (Four Semesters in two years) with continuous assessment [30% with non-inclusion in Cumulative Grade point average (CGPA)].

To obtain a Master's Degree M.A./M.Sc. in Mathematics, a candidate is required to earn [illegible] credits with grade E or higher. For this each Semester will offer 36 credits. To earn credits for a paper, a candidate shall be required to obtain grade E or higher (or equivalent marks percentage) in the theory/practical examination. A candidate has to pass in the continuous assessment (internal) as well as in that paper separately. However, the grade point/marks obtained in the continuous assessment will not be included in Semester Grade Point Average (SGPA). In continuous assessment and End of Semester Examination (EoSE) separate grades will be awarded. The candidate will not be permitted to appear in EoSE of a particular credit (i) if he/she does not meet out 75% attendance requirement, or (ii) he/she fails to secure a Semester Grade Point Average (SGPA) of 1.5 in the continuous assessment.

The Credit Courses have been classified as

a) Compulsory Core Courses (CCC)

b) Elective Core Courses (ECC)

A course is identified by a course code designated by a string of six alphanumeric characters and a course title. In a course code the first three characters of the string indicate the Department offering the course and the later three alphanumeric characters designate a particular course. In the case of compulsory core course the fourth character identifies the semester numeric digit and in case of the elective core courses the fourth character indicates the cluster of specialization. For compulsory or elective theory core courses the fifth character is '0' and for laboratory core course it is '1'.

First Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 701	Algebra-I	CCC	6	6	3
2.	MAT 702	Real Analysis	CCC	6	6	3
3.	MAT 703	Differential Equations-I	CCC	6	6	3
4.	MAT 704	Differential Geometry	ECC	6	6	3
5.	MAT 705	Dynamics of Rigid Bodies	ECC	6	6	3
6	MAT 706	Calculus of Variation and Special Function-I	ECC	6	6	3
		Total Credits in the Semester		36		

12

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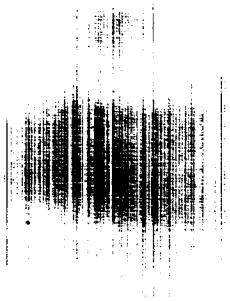
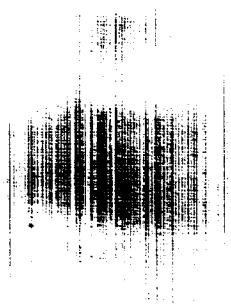
Second Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 801	Algebra-II	CCC	6	6	3
2.	MAT 802	Topology	CCC	6	6	3
3.	MAT 803	Differential Equations-II	CCC	6	6	3
4.	MAT 804	Riemannian Geometry and Tensor Analysis	ECC	6	6	3
5.	MAT 805	Hydrodynamics	ECC	6	6	3
6.	MAT 806	Special Functions-II	ECC	6	6	3
		Total Credits in the Semester		36		

EoSE : End of Semester Examination





(13

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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.	RC	Relativity and Cosmology
F.	IM	Industrial Mathematics
G.	MHD	Magnetohydrodynamics
H.	CA	Computer Applications
I.	NA	Numerical Analysis

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 Programming-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	RC	Relativistic Mechanics	-	6
MAT E02	RC	General Relativity and cosmology	MAT E01	6
MAT F01	IM	Industrial Mathematics-I	-	6
MAT F02	IM	Industrial Mathematics-II	MAT F01	6
MAT G01	MHD	Magnetohydrodynamics-I	-	6
MAT G02	MHD	Magnetohydrodynamics-II	MAT G01	6
MAT H01	CA	Computer Applications-Theory	-	6
MAT H02	CA	Computer Applications-Practical	MAT H01	6
MAT I01	NA	Numerical Analysis-I	-	6
MAT I02	NA	Numerical Analysis-II	MAT I01	6

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Third Semester

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week	EoSE Duration (Hrs.)
1.	MAT 901	Functional Analysis-I	CCC	6	6	3
2.	MAT 902	Viscous Fluid Dynamics-I	CCC	6	6	3
3.	MAT 903	Integral Transforms	CCC	6	6	3

Candidates are required to opt any three 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 X01	Functional Analysis-II	CCC	6	6	3
2.	MAT X02	Viscous Fluid Dynamics-II	CCC	6	6	3
3.	MAT X03	Integral Equations	CCC	6	6	3

Candidates are required to opt the corresponding three 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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MA/M.Sc. (Previous) Mathematics Examination
Scheme of Examination
Semester System

Semester – I

Note: 1. Papers MAT 701, MAT 702 and MAT 703 are compulsory (CCC) and Papers MAT 704, MAT 705, and MAT 706 are elective (ECC).

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-I: MAT 701 : 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). Sylow's theorems (without proof), Cauchy's theorem for finite abelian groups.

Unit-2

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

Unit - 3

Polynomial rings and irreducibility criteria. 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.

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice Hall of India (PHI), New Delhi, 2004
2. N.S.Gopalkrishnan, University Algebra, New Age International, 1986.
3. M.A. Zameeruddin and Surjeet Singh, Modern Algebra, Vikas Publishing,2006

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4. D. S. Chauhan and K. N. Singh, Studies in Algebra, JPH, 2006
5. G.C.Sharma, Modern Algebra, Shivlal Agrawal & Co., Agra,1998.
6. Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), Narosa Publishing House, 1999.
7. David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.
8. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
9. I. N. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006.
10. Michael Artin, Algebra (2nd edition), Pearson Prentice Hall, 2011.

Paper - II MAT 702 : 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.

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.

Reference Books:

1. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., N.D., 1995.
2. S.C Malik and Savita Arora, Mathematical Analysis, New Age International, 1992.
3. T. M. Apostol, Mathematical Anslysis, Narosa Publishing House, New Delhi, 1985
4. R.R. Goldberg, Real Analysis, Oxford & IBH Publishing Co., New Delhi, 1970.
5. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
6. Walter Rudin, Real and Complex Analysis, Tata McGraw Hill Pub. Co. Ltd., 1986.

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7. I.N. Natansen, Theory of Functions of a Real Variable, Fredrik Pub. Co., 1964.

Paper – 3 : MAT 703 : 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. The 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 about a regular singular point (Method of Forbenius) for different cases, Particular integrals and the point at infinity.

Unit – 4

Partial differential equations of second order with variable co-efficients- Monge's method.

Reference Books:

1. J.L.Bansal and H.S.Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
4. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.
5. E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, Orient Longman, 1902.
8. A.R.Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

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Paper- 4 : MAT 704 : 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

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.

Reference Books:

1. R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.
2. Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.
3. Barry Spain, Tensor Calculus, Radha Publ. House Calcutta,1988.
4. J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog , 2013.
5. T.J. Willmore - An Introduction to Differential Geometry. Oxford University Press.1972.
6. [illegible], Riemanian Geometry and Tensor Calculus, Cambridge Univ Press, 2008.

9

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7. Thorpe, Elementary Topics in Differential Geometry, Springer Verlag, N.Y. (1985).

8. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice Hall, 1977.

Paper- 5 : MAT 705: 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.

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.

Reference Books:

1. N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.
2. M. Ray and H.S. Sharma, A Text Book of Dynamics of a Rigid Body, Students' Friends & Co., Agra, 1984.
3. H. Goldstein, Classical Mechanics, Narosa, 1990.
4. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill, 1991.
5. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998

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Paper – 6 : MAT 706: 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, 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 $Q_n(x)$.

Reference Books:

1. J.L.Bansal and H.S.Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. J.N.Sharma and R.K.Gupta, Differential Equations with Special Functions, Krishna Prakashan , 1991.
4. Earl D. Rainville, Special Functions, Macmillan Company, New York, 1960.
5. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
6. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

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Semester – II

Note: 1. Papers **MAT 801, MAT 802** and **MAT 803** are compulsory (CCC) and Papers **MAT 804, MAT 805** and **MAT 806** are elective (ECC).

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 801 : 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 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 their computations. Characteristic polynomial, minimal polynomial and their properties. 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.

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice – Hall of India (PHI), New Delhi, 2004
2. N.S.Gopalkrishnan, University Algebra, New Age International, 1986.
3. Qazi Zameeruddin and Surjeet Singh, Modern Algebra, Vikas Publishing,2006
4. D. S. Chauhan and K. N. Singh, Studies in Algebra, JPH, 2006
5. G.C.Sharma, Modern Algebra, Shivlal Agrawal & Co., Agra,1998
6. Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), Narosa Publishing House, 1999.
7. David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd. Singapore, 2004

12

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8. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
9. I.N. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006.
10. Michael Artin, Algebra (2nd edition), Pearson Prentice Hall, 2011.

Paper – 2 : MAT 802 : 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. One point compactification theorem. Connected and Locally connected spaces, Continuity and Connectedness.

Reference Books:

1. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., N.D., 1995.
2. S.C.Malik and Savita Arora, Mathematical Analysis, New Age International, 1992.
3. James R. Munkres, Topology, 2nd Edition, Pearson International, 2000.
4. J. Dugundji, Topology, Prentice-Hall of India, 1975.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.

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Paper 3 : MAT 803: 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 Part 'B'. All questions carry equal marks.

Unit – 1

Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem of first 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.

Reference Books:

1. J.L.Bansal and H.S.Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
4. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.
5. E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, Orient Longman,1902.
8. A.R.Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

/141

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JAIPUR

Paper – 4 : MAT 804 : 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 par 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, 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.

Reference Books:

1. R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.
2. Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.
3. Barry Spain, Tensor Calculus, Radha Publ. House Calcutta, 1988.
4. J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog , 2013.
5. T.J. Willmore - An Introduction to Differential Geometry. Oxford University Press.1972.
6. Weatherburn, Reimanian Geometry and Tensor Clculus, Cambridge Univ. Press, 2008.
7. Thorpe, Elementary Topics in Differential Geometry, Springer Verlag, N.Y. (1985).
8. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice Hall, 1977.

15

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Paper – 5 : MAT 805: 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 [illegible] 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 [illegible], vortex pair, vortex doublet, vortex inside and outside circular cylinder, four vortices, motion of vortex situated at the origin and stream lines.

Reference Books:

1. M.D. Raisinghania, Hydrodynamics, S. Chand & Co. Ltd., N.D. 1995.
2. M. Ray and G.C. Chadda, A Text Book on Hydrodynamics, Students' Friends & Co., Agra, 1985.
3. N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.
4. H. Goldstein, Classical Mechanics, Narosa, 1990.
5. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill, 1991.
6. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

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Paper-6 : MAT 806 : 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 (20 marks). 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.

Recommended books:

1. [illegible] Bansal and H.S.Dhami, Differential Equations Vol-II, JPH, 2004.
2. [illegible] Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. J.N.Sharma and R.K.Gupta, Differential Equations with Special Functions, Krishna Prakashan , 1991.
4. Earl D. Rainville, Special Functions, Macmillan Company, New York, 1960.
5. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
6. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

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M.A./M.Sc. (Final) Mathematics
Semester Scheme (Semester III and IV)

Semester - III

Note: (i) Paper **MAT 901** and **MAT 902** and **MAT 903** are compulsory (CCC) in Semester III.
(ii) Candidates are required to opt any three 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.**
(iii) 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.

Compulsory Papers (CCC)

Paper I: MAT 901 : 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: Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergent, Cauchy sequence. Complete metric space, Examples of Complete & Incomplete metric spaces.

Unit – 2

Banach contraction theorem and applications. Baire's category theorem, Ascoli-Arzela theorem, compactness, compact spaces and connected metric spaces. Separable metric space with examples.

Unit - 3

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 – 4

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.

Reference Books:

1. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons., 1978.
2. A. E. Taylor, Introduction to Functional Analysis, John Wiley, 1958.

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3 A. Bowers and N. Kalton, An Introductory Course in Functional Analysis, Springer Verlog, 2014.
4. W. Rudin, Functional Analysis, McGraw-Hill, 1973.

Paper-2 : MAT 902 : 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. The syllabus 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.

Reference Books:

1 J.L. Bansal, Viscous Fluid dynamics, JPH, Jaipur , 2008.
2 M.D.Raisinghania, Fluid Dynamics, S.Chand, 2003
3 F. Chorlton, A Text Book of Fluid Dynamics, CBC, 1985.
4 S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall, 1976.

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5. S. I. Pai, Viscous Flow Theory I- Laminar Flow, D. Van Nostrand Co., Inc., Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F.M.White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

Paper – 3 : MAT 903 : 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 [illegible]. 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

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

Reference Books:

1. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and their Applications, Taylor and Francis Group, 2014.
2. Abdul J. Jerry, Introduction to Integral Equations with applications, Marcel Dekkar Inc. NY, 1999.
3. L.G.Chambers, Integral Equations: A short Course, Int. Text Book Company Ltd. 1976.
4. Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill, 1965.

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Optional Papers: (ECC)

Paper – 4 : 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

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.

Reference Books:

1. W. Prager, Introduction to Mechanics of Continua, Lexinton Mass, Ginn, 1961.
2. A.C. Eringen, Mechanics of Continua, Wiley, 1967.
3. T.J. Chung, Continuum Mechanics, Prentice- Hall, 1988.

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Paper – 5 : 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.

Reference Books:

1. J.L. Bansal, Viscous Fluid dynamics, JPH, Jaipur , 2008.
2. M.D.Raisinghania, Fluid Dynamics, S.Chand, 2003.
3. F. Chorlton, A Text Book of Fluid Dynamics, CBC, 1985.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall, 1976.
5. S. I. Pai, Viscous Flow Theory I- Laminar Flow, D. Van Nostrand Co., Inc., Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F.M.White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

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Paper-6: 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.

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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.

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Reference Books:

1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., N.Delhi, 2007.
2. S.D.Sharma, Operations Research, Kedar Nath Ram Nath and co. Meerut, 2005.
3. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research Concepts and Cases (9th Edition), Tata McGraw Hill, 2010.
4. Hamdy A. Taha, Operations Research, An Introduction (9th edition), Prentice-Hall, 2010.
5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

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23

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Paper – 7: 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.

Reference Books:

1. N. Deo, Graph Theory with Applications to Computer Science, Prentice-Hall of India, 1979.
2. C.L. Liu, Elements of Discrete Mathematics, (Second Edition), McGraw Hill, International Edition, 1986.
3. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1995.
4. S. Wiitala, Discrete Mathematics. A Unified Approach, McGraw-Hill Book Co., 1987.
5. Ian Anderson, A First course in Combinatorial Mathematics, Springer, 1989.

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Paper – 8 : MAT E01 : 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.

Reference Books:

1. J.V. Narlikar, Lectures on General Relativity and Cosmology, Macmillan Co. Ltd. India, N.Delhi, 1978.
2. C. Moller, The Theory of Relativity, Oxford Clarendon Press, 1952.
3. P.G. Bergmann, Introduction to the Theory of Relativity, Prentice Hall of India, 1969.
4. J.L. Anderson, Principles of Relativity Physics, Academic Press, 1967.
5. W. Rindler, Essential Relativity, Van Nostrand Reinhold Company, 1969.
6. V. A. Ugarov, Special Theory of Relativity, Mir Publishers, 1979.

125

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Paper – 9 : MAT F01: 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.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.

Reference Books:

1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., [illegible], 2007.
2. [illegible] Sharma, Operations Research, Kedar Nath Ram Nath and co. Meerut, 2005.
3. [illegible] Taha, Operations Research: An Introduction; MacMillan Publishing Company, New York, 1982.
4. F.S. Hillier and G.J. Leiberman, Introduction to Operations Research; Holden Day, 1962.
5. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

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Paper – 10: MAT G01: 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 typequestions 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's 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.

Reference Books:

1. [illegible] Gaur, Magnetofluiddynamics of Viscous Fluids, JPH, Jaipur, 1994.
2. [illegible] Cramer and S.I.Pai, Magnetofluiddynamics for Engineers and Applied Physicists, McGraw-Hill, N.Y., 1973.
3. P.A. Davidson, An Introduction to Magnetohydrodynamics, Cambridge Univ. Press, U.K., 2001.
4. J.A.Shercliff, A Textbook of Magnetohydrodynamics, Pergamon Press., 1965.
5. K.R. Cramer and S.I. Pai, Magnetofluid Dynamics for Engineers and Applied Physicists, McGraw- Hill Book Co., 1973.

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Paper – 11: MAT H01: 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

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.

Reference Books:

1. V.Rajaraman, Programming in C, PHI, N.Delhi, 2002.
2. [illegible] Ganeshkar, Let Us C, BPD Publications, 2008.
3. [illegible]ezzi and M. Jazayeri, Programming Languages Concepts, John Wiley, 1977.
4. [illegible]otty & H.F. Ledgard, Programming Language Landscape, Galgotia Publication, 1981.
5. R.C. Hutchinson and S.B. Just, Programming using the C Language, McGraw-Hill.
6. B.S. Gottfried, Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill, 1996.
7. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, PHI, N.Delhi. 1999.
8. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB, Cambidge Univ. Press, 2001.
9. Duane hanselman and Bruce Littlefield, Mastering Matlab-7, Pearson Education 2005.
10. William J. Palm III, Introduction to Matlab-7 for Engineers, McGraw Hill, 2005.

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Paper – 12 : MAT 101 : 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, Muller'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-Doolittc'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.

Reference Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, 1979.
2. V. Rajaraman, Computer Oriented Numerical Methods, PHI, 1993.
3. M.K. Jain, S.R.K. Eyenger and R.K. Jain, Numerical Methods for Mathematics and Applied Physicists, Wiley-Eastern Pub., N.Delhi, 2005.
4. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
5. C. F. Gerald and P. O. Wheatley, App;ied Numerical Analysis, Pearson Education, India,7th edition, 2008.
6. C.F. Gerald, P.O. Wheatley, Applied Numerical Analysis, Addison-Wesley, 1998.
7. S. D. Conte, C de Boor, Elementary Numerical Analysis, McGraw-Hill, 1980.
8. C.E. Froberg, Introduction to Numerical Analysis, (Second Edition). Addition-Wesley, 1979.

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Semester – IV

Note: (i) Paper **MAT X01** and **MAT X02** and **MAT X03** compulsory in Semester IV.

(ii) Candidates are required to opt the corresponding three 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 .

(iii) 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 X01 : 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. The syllabus 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

Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples. Inner product spaces.

Unit – 2

Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Phythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples.

Unit – 3

Orthonormal sets, Bessel's inequality, Existence of orthonormal bases by Gram-schimidt orthonormalization process. Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.

Unit – 4

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. Eigen values and eigen vectors of an operator. Spectrum of an operator Spectral theorem.

Reference Books:

1. E. Kreyszig. Introductory Functional Analysis with Applications. John Wiley and Sons., 1978.

30

Dy. Registrar
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2. A. E. Taylor, Introduction to Functional Analysis, John Wiley, 1958.

3. A. Bowers and N. Kalton, An Introductory Course in Functional Analysis, Springer Verlog, 2014.
4. W. Rudin, Functional Analysis, McGraw-Hill, 1973.

Paper – 2: MAT X02 : 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.

Reference Books:

1. J.L. Bansal, Viscous Fluid dynamics, JPH, Jaipur , 2008.
2. M.D.Raisinghania, Fluid Dynamics, S.Chand, 2003.
3. F. Chorlton, A Text Book of Fluid Dynamics, CBC, 1985.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall, 1976.
5. S. I. Pai, Viscous Flow Theory I- Laminar Flow, D. Van Nostrand Co., Inc., Princeton, New Jersey, N.Y. Landon, Toronto, 1956

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F. M. White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974

Paper [illegible] MAT X03 : 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 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.

Reference Books:

1. [illegible] Swarup, Integral Equations, Krishna Publications, Meerut.
2. M.D Raisinghania, Integral Equations and Boundary Value Problems, S.Chand, 2010.
3. Abdul J. Jerry. Introduction to Integral Equations with applications, Marcel Dekkar Inc. NY, 1999.
4. L.G.Chambers, Integral Equations: A short Course, Int. Text Book Company Ltd. 1976.

32

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Optional Paper (ECC)
Paper – 4 : 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 equatiors (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.

Reference Books:

4. W. Prager, Introduction to Mechanics of Continua, Lexinton Mass, Ginn, 1961.
5. A.C. Eringen, Mechanics of Continua, Wiley, 1967.
6. T.J. Chung, Continuum Mechanics, Prentice- Hall, 1988.

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Paper [illegible] MAT B02 : Boundary Layer Theory – II
[illegible] 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.

Reference Books:

1. [illegible] Bansal, Viscous Fluid dynamics, JPH, Jaipur , 2008.
2. [illegible] Chhinghania, Fluid Dynamics, S.Chand, 2003.
3. [illegible]ton, A Text Book of Fluid Dynamics, CBC, 1985.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall, 1976.
5. S. I. Pai, Viscous Flow Theory I- Laminar Flow, D. Van Nostrand Co., Inc., Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F.M.White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

134

Dy. Regis[illegible]
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Paper - 6 : MAT C02 : Mathematical Programming - II
[illegible] 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.

Reference Books:

1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., N.Delhi, 2007.
2. S.D.Sharma, Operations Research, Kedar Nath Ram Nath and co. Meerut, 2005.
3. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research Concepts and Cases (9th Edition), Tata McGraw Hill, 2010.
4. Hamdy A. Taha, Operations Research, An Introduction (9th edition), Prentice-Hall, 2010.
5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

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Paper – 7 : MAT D02: Graph Theory – II
[illegible] hours per week. (6 credits)
[illegible] 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

[illegible]ring. 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.

Reference Books:

1. N. Deo, Graph Theory with Applications to Computer Science, Prentice-Hall of India, 1979.
2. C.L. Liu, Elements of Discrete Mathematics, (Second Edition), McGraw Hill, International Edition, 1986.
3. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1995.
4. S. Witala, Discrete Mathematics: A Unified Approach, McGraw-Hill Book Co., 1987.
5. Ian Anderson, A First course in Combinatorial Mathematics, Springer, 1989.

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Paper - 8 : MAT E02 : 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.

Reference Books:

1. J.V. Narlikar, Lectures on General Relativity and Cosmology, Macmillan Co. Ltd. India, N.Delhi, 1978.
2. C. Moller, The Theory of Relativity, Oxford Clarendon Press, 1952.
3. P.G. Bergmann, Introduction to the Theory of Relativity, Prentice Hall of India, 1969.
4. R.U. Sexl & H.K. Urbantke, Principles of Relativity Physics, Academic Press, 1967.
5. W. Rindler, Essential Relativity, Van Nostrand Reinhold Company, 1969.
6. V. A. Ugarov, Special Theory of Relativity, Mir Publishers, 1979.

137

Dy. Registrar (Academic)
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JAIPUR

Paper – 9 : MAT F02 : 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.

Reference Books:

1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., N.Delhi, 2007.
2. S.D.Sharma, Oporations Research, Kedar Nath Ram Nath and co. Meerut, 2005.
3. H.A.Taha, Operations Research: An Introduction; MacMillan Publishing Company, New York, 1982.
4. F.S. Hillier and G.J. Leiberman, Introduction to Operations Research; Holden Day, 1962.
5. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

Paper – 10 : MAT G02: 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.

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JAIPUR

Unit - 1

MHD flow near a stagnation point. MHD Reyleigh's flow. MHD Stoke's flow past a sphere, [illegible] 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.

Reference Books:

1. J.L.Bansal, Magnetofluiddynamics of Viscous Fluids, JPH, Jaipur, 1994.
2. K.R. Cramer and S.I.Pai, Magnetofluiddynamics for Enginners and Applied Physicists, McGraw-Hill, N.Y., 1973.
3. P.A. Davidson, An Introduction to Magnetohydrodynamics, Cambridge Univ. Press, [illegible] 2001.
4. [illegible]ercliff, A Textbook of Magnetohydrodynamics, Pergamon Press., 1965.
5. K.R. Cramer and S.I. Pai, Magnetofluid Dynamics for Engineers and Applied Physicists, McGraw- Hill Book Co., 1973.

Paper – 11: MAT H02: Computer Applications- Practical
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 give practicals.

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

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.

Distribution of Marks:

Five Practicals – 15 Marks each	= 75 Marks
Practical Record	= 10 Marks
[illegible] Voce	= 15 Marks
[illegible] 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

Dy. Registrar (Academic)
University of Rajasthan
JAIPUR

Each candidate has to prepare his/her practical record.

Paper 12 : MAT 102 : 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

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

Reference Books:

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 1979.
2. V.Rajaraman, Computer Oriented Numerical Methods, PHI, 1993.
3. M.K.Jain, S.R.K. Eyenger and R.K. Jain, Numerical Methods for Mathematics and Applied Physicists, Wiley-Eastern Pub., N.Delhi, 2005.
4. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
5. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th edition, 2008.
6. C.F. Gerald, P.O. Wheatley, Applied Numerical Analysis, Addison Wesley, 1998.
7. S. D. Conte, C de Boor, Elementary Numerical Analysis, McGraw-Hill, 1980.
8. G.E. Froberg, Introduction to Numerical Analysis, (Second Edition), Addition-Wesley, 1979.

(40)

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