SHRI JAGDISHPRASAD JHABARMAL TIBREWALA UNIVERSITY, CHUDELA, JHUNJHUNU, RAJASTHAN

SYLLABUS

M.Sc. (Mathematics)

(Master of Science)

SHRI JAGDISHPRASAD JHABARMAL TIBREWALA UNIVERSITY
CHUDELA, JHUNJHUNU, RAJASTHAN

INSTITUTE OF SCIENCE
DEPARTMENT OF MATHEMATICS
TEACHING AND EXAMINATION SCHEME AND DETAILED SYLLABUS FOR

MASTER OF SCIENCE

EFFECTIVE FROM ACADEMIC SESSION 2021 – 22

Year: I **Semester: I**

S. No.	Subject Code	Subject Name	Hrs./Week			Exam Hrs.	Maximum & Minimum Marks		
			L	T	P		Internal/ Min. Pass Marks	External/ Min. Pass Marks	Total/Min. Pass Marks
Theory									
1	MAT-101	Algebra – I	4	0	0	3	30/12	70/28	100/40
2	MAT-102	Real Analysis	4	0	0	3	30/12	70/28	100/40
3	MAT-103	Differential Equations – I	4	0	0	3	30/12	70/28	100/40
4	MAT-104	Differential Geometry	4	0	0	3	30/12	70/28	100/40
5	MAT-105	Dynamics of Rigid Bodies	4	0	0	3	30/12	70/28	100/40
6	MAT-106	Calculus of Variation and Special Function – I	4	0	0	3	30/12	70/28	100/40
Total			**24**						**600**
Total Teaching Load			**24**						

L: Lecture, T: Tutorial, P: Practical

YEAR: I **SEMESTER: I**

MAT 101: Algebra – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Direct product of groups (External and Internal). Isomorphism theorems – Diamond isomorphism theorem, Butterfly Lemma, Conjugate classes (Excluding p-groups). Sylow's theorem (without proof), Cauchy's theorem for finite abelian groups.	12
II	Commutators, Derived subgroups. Normal series and Solvable groups, Composition series, Refinement theorem and Jordan – Holder theorem for infinite groups.	10
III	Polynomial rings and irreducibility criteria, Field theory – Extension fields, Algebraic and Transcedental extensions, Separable and inseparable extensions, Normal extensions, Splitting fields.	11
IV	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.	11
	Total	44

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

YEAR: I **SEMESTER: I**

MAT 102: Real Analysis **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Algebra and algebra 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.	11
II	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.	12
III	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.	10
IV	Summable functions, Space of square summable functions, Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem.	11
	Total	44

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

YEAR: I **SEMESTER: I**

MAT 103: Differential Equations – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	10
II	Total Differential equations, Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.	12
III	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.	11
IV	Partial differential equations of second order with variable co-efficient – Monge's method.	11
	Total	44

Reference Books:

1. J. L. Bansal and H.S. Dhami, Differential Equations Vol – II, JPH, 2004.
2. M. D. Raisighania, 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.

YEAR: I **SEMESTER: I**

MAT 104: Differential Geometry **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	11
II	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.	12
III	Normal curvature, Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussian curvature, Radius of curvature of a given section through any point on $z = f(x, y)$, Lines of curvature, Principal radii, Relation between fundamental forms.	10
IV	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.	11
	Total	44

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. Weatherbum, Riemannian Geometry and Tensor Calculus, 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.

YEAR: I **SEMESTER: I**

MAT -105: Dynamics of Rigid Bodies **(L, T, P) = 4(4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	10
II	The compound pendulum, Centre of percussion. Conservation of momentum (linear and angular) and energy for finite as well as impulsive forces.	11
III	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.	10
IV	Lagrange's equations for holonomous dynamical system, Energy equation for conservative field, Small oscillations, Hamilton's equations of motion, Hamilton's principle and principle of least action.	13
	Total	44

Reference Books:

1. N. C. Rana and P.S. Joag, Classica 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.

YEAR: I **SEMESTER: I**

MAT 106: Calculus of Variation and Special Function – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	11
II	Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form.	10
III	Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous functions 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.	14
IV	Legendre polynomials and functions $P_n(x)$ and $Q_n(x)$.	9
	Total	44

Reference Books:

1. J. L. Bansal and H.S. Dhami, Differential Equations Vol – II, JPH, 2004.
2. M. D. Raisighania, 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, Newyork, 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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MASTER OF SCIENCE

EFFECTIVE FROM ACADEMIC SESSION 2021 – 22

Year: I **Semester: II**

S. No.	Subject Code	Subject Name	Hrs./Week			Exam Hrs.	Maximum & Minimum Marks		
			L	T	P		Internal/ Min. Pass Marks	External/ Min. Pass Marks	Total/Min. Pass Marks
Theory									
1	MAT-201	Algebra – II	4	0	0	3	30/12	70/28	100/40
2	MAT-202	Topology	4	0	0	3	30/12	70/28	100/40
3	MAT-203	Differential Equations – II	4	0	0	3	30/12	70/28	100/40
4	MAT-204	Riemannian Geometry and Tensor Analysis	4	0	0	3	30/12	70/28	100/40
5	MAT-205	Hydrodynamics	4	0	0	3	30/12	70/28	100/40
6	MAT-206	Special Functions –II	4	0	0	3	30/12	70/28	100/40
Total			**24**						**600**
Total Teaching Load			**24**						

L: Lecture, T: Tutorial, P: Practical

YEAR: I **SEMESTER: II**

MAT 201: Algebra – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dual maps, Annihilator.	9
II	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.	11
III	Determinants of matrices and their computations. Characteristic polynomial, minimal polynomial and eigen values. Real inner product space, Schwartz's inequality.	12
IV	Orthogonality, Bessel's inequality, Adjoint, Self-adjoint linear transformations and matrices. Orthogonal linear transformation and matrices, Principal Axis Theorem.	12
	Total	44

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

YEAR: I **SEMESTER: II**

MAT 202: Topology **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Topological spaces, Subspaces, Open sets, Closed sets, Neighborhood system, Bases and sub – bases.	10
II	Continuous mapping and Homeomorphism, Nets, Filters.	10
III	Separation axioms (T_0, T_1, T_2, T_3, T_4). Compact and locally compact spaces. Continuity and Compactness.	12
IV	Product and Quotient spaces, One point compactification theorem. Connected and Locally connected spaces, Continuity and Connectedness.	12
	Total	44

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.

YEAR: I **SEMESTER: II**

MAT 203: Differential Equations – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem of first order partial differential equation.	10
II	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.	11
III	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.	11
IV	Green's Functions: Non – homogeneous Sturm – Liouville boundary 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.	12
	Total	44

Reference Books:

1. J. L. Bansal and H.S. Dhami, Differential Equations Vol – II, JPH, 2004.
2. M. D. Raisighania, 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.

YEAR: I **SEMESTER: II**

MAT 204: Riemannian Geometry and Tensor Analysis **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	10
II	Tensor Analysis – Kronecker delta. Contravariant and Covariant tensors, Symmetric tensors, Quotient aw of tensors, Relative tensor. Riemann space. Metric tensor, Indicator, Permutation symbols and Permutation tensors.	11
III	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.	12
IV	Riemann – Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.	11
	Total	44

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. Weatherbum, Riemanian Geometry and Tensor Calculus, 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.

YEAR: I **SEMESTER: II**

MAT 205: Hydrodynamics **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	12
II	Euler's hydrodynamics equations, Bernoulli's theorem. Helmhotz equations. Cauchy's integral.	9
III	Motion due to impulsive forces. Motion in two – dimensions, Stream function, Complex potential. Sources, Sinks, Doublets, Images in two – dimensions.	10
IV	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 vortex situated at the origin and stream lines.	13
	Total	44

Reference Books:

1. M.D. Raisighania, 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.

YEAR: I **SEMESTER: II**

MAT 206: Special Functions – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Bessel functions $J_n(x)$.	10
II	Hermite polynomials $H_n(x)$, Laguerre and Associated Laguerre polynomials.	10
III	Jacobi Polynomial: Definition and its special cases, Bateman's generating function, Rodrigue's formula, orthogonality, recurrence relations, expansion in series of polynomials.	11
IV	Chebyshev polynomials $T_n(x)$ and $U_n(x)$: Definition, Solutions of Chebyshev's equation, expansions, Generating functions, Recurrence relations, Orthogonality.	13
	Total	44

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, 198

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MASTER OF SCIENCE

EFFECTIVE FROM ACADEMIC SESSION 2022 – 23

Year: II **Semester: III**

S. No.	Subject Code	Subject Name	Hrs./Week			Exam Hrs.	Maximum & Minimum Marks		
			L	T	P		Internal/ Min. Pass Marks	External/ Min. Pass Marks	Total/Min. Pass Marks
Theory									
1	MAT-301	Functional Analysis – I	4	0	0	3	30/12	70/28	100/40
2	MAT-302	Viscous Fluid Dynamics – I	4	0	0	3	30/12	70/28	100/40
3	MAT-303	Integral Transforms	4	0	0	3	30/12	70/28	100/40
4	MAT-304	Mathematical Programming – I	4	0	0	3	30/12	70/28	100/40
5	MAT-305	Relativistic Mechanics	4	0	0	3	30/12	70/28	100/40
6	MAT-306	Numerical Analysis – I	4	0	0	3	30/12	70/28	100/40
Total			**24**						**600**
Total Teaching Load			**24**						

L: Lecture, T: Tutorial, P: Practical

YEAR: II **SEMESTER: III**

MAT 301: Functional Analysis – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergent, Cauchy sequence. Complete metric space.	11
II	Banach contraction theorem, Baire's category theorem, compact sets, compact spaces, Separable metric space and connected metric spaces.	10
III	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.	12
IV	Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundedness theorem.	11
	Total	44

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

YEAR: II **SEMESTER: III**

MAT 302: Viscous Fluid Dynamics – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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's equations of motion.	10
II	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.	13
III	Exact solutions of Navier – Stokes's equations, Velocity distribution for plane Couette flow, Plane Poiseuille flow, Generalized plane Couette flow, Hagen – Poiseuille flow, Flow in tubes of uniform cross – sections.	10
IV	Flow between two concentric rotating cylinders. Stagnation point flows: Hiemenz flow, Homann flow. Flow due to a rotating disc.	11
	Total	44

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 1- Laminar Flow, D. Van Nostrand Co., Ing. Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F.M.White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

YEAR: II **SEMESTER: III**

MAT 303: Integral Transforms **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Fourier transform – Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.	11
II	Mellin transform – Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem.	12
III	Laplace transform – Definition and its properties. Rules of manipulation. Laplace transform of derivative and integrals. Properties of inverse Laplace transform. Convolution theorem.	10
IV	Complex inversion formula. Infinite Hankel transform – Definition and elementary properties. Hankel transform of derivatives. Inversion theorem. Parseval Theorem.	11
	Total	44

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.

YEAR: II **SEMESTER: III**

MAT 304: Mathematical Programming – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Separating and supporting hyperplane theorems. Revised simplex method to solve Linear Programming problems, Bounded variable problems.	10
II	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.	12
III	Se**parab**le 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.	12
IV	Dynamic programming: Introduction, Bellman principle of optimality, solution of problems with finite number stages, solution of L.P.P. by dynamic programming.	10
	Total	44

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.

YEAR: II **SEMESTER: III**

MAT 305: Relativistic Mechanics **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	12
II	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.	11
III	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.	10
IV	Minkowski space, Space-like, Time-like and Light-like intervals, Null cone, Relativity and Casualty, Proper time, World line of a particle. Principles of Equivalence and General Covariance.	11
	Total	44

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.

YEAR: II **SEMESTER: III**

MAT 306: Numerical Analysis – I **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Iterative methods – Theory of iteration method, Acceleration of the convergence, Chebyshev method, Muler's method, Methods for multiple and complex roots.	11
II	Newton-Raphson method for simultaneous equations, Convergence of iteration process in the case of several unknowns. Solution of polynomial equation – Polynomial equation, Real and complex roots, Synthetic division, the Birge-Vieta, Bairstow and Graeffe's root squaring method.	12
III	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.	10
IV	Eigen value problems – Basic properties of eigen values and eigen vector, Power methods, Method for finding all eigen values of a matrix. Jacobi, Given's and Rutishauser method. Complex eigen values.	11
	Total	44

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.

SHRI JAGDISHPRASAD JHABARMAL TIBREWALA UNIVERSITY
CHUDELA, JHUNJHUNU, RAJASTHAN

INSTITUTE OF SCIENCE
DEPARTMENT OF MATHEMATICS
TEACHING AND EXAMINATION SCHEME AND DETAILED SYLLABUS FOR

MASTER OF SCIENCE

EFFECTIVE FROM ACADEMIC SESSION 2022 – 23

Year: II **Semester: IV**

S. No.	Subject Code	Subject Name	Hrs./Week			Exam Hrs.	Maximum & Minimum Marks		
			L	T	P		Internal/ Min. Pass Marks	External/ Min. Pass Marks	Total/Min. Pass Marks
Theory									
1	MAT-401	Functional Analysis – II	4	0	0	3	30/12	70/28	100/40
2	MAT-402	Viscous Fluid Dynamics – II	4	0	0	3	30/12	70/28	100/40
3	MAT-403	Integral Equations	4	0	0	3	30/12	70/28	100/40
4	MAT-404	Mathematical Programming – II	4	0	0	3	30/12	70/28	100/40
5	MAT-405	General Relativity and cosmology	4	0	0	3	30/12	70/28	100/40
6	MAT-406	Numerical Analysis – II	4	0	0	3	30/12	70/28	100/40
Total			**24**						**600**
Total Teaching Load			**24**						

YEAR: II **SEMESTER: IV**

MAT 401: Functional Analysis – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples. Inner product spaces.	11
II	Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Pythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples.	10
III	Orthonormal sets, Bessel's inequality, Existence of orthonormal bases by Gram-Schmidt orthogonalization process. Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.	11
IV	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.	12
	Total	44

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

YEAR: II **SEMESTER: IV**

MAT 402: Viscous Fluid Dynamics – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	11
II	Equation of energy, Temperature distribution: Between parallel plates, in a pipe, between two concentric rotating cylinders.	10
III	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.	12
IV	Concept of boundary layer, Derivation of velocity and thermal boundary equations in two-dimensional flow. Boundary layer on flat plat (Balsius – Topfer solution), Simple solution of thermal boundary layer equation for Pr = 1.	11
	Total	44

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,
5. S. I. Pai, Viscous Flow Theory Laminar Flow, D. Van Nostrand Co., Ing., 1976.Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F.M.White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

YEAR: II **SEMESTER: IV**

MAT 403: Integral Equations **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	10
II	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.	10
III	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.	12
IV	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.	12
	Total	44

Reference Books:

1. Shanti 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.

YEAR: II **SEMESTER: IV**

MAT 404: Mathematical Programming – II **(L, T, P) = 4(4+0+0)**

Unit	Contents of Course	Hrs.
I	Convex function, Quadratic forms, constrained problem of maxima and minima, Lagrangian method, Non-linear programming: Formulation and Graphical method.	11
II	Non-linear programming and its fundamental ingredients, Kuhn-Tucker necessary and sufficient conditions, Saddle point, Saddle-point theorems.	12
III	Quadratic Programming: Kuhn-Tucker conditions, Wolfe method, Duality in Quadratic Programming.	10
IV	Beals method to solve QPP, Geometric Programming: Formulation, geometric arithmetic inequality, necessary conditions of optimality.	11
	Total	44

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.

YEAR: II **SEMESTER: IV**

MAT 405: General Relativity & Cosmology **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	11
II	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.	10
III	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.	11
IV	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.	12
	Total	44

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.

YEAR: II **SEMESTER: IV**

MAT 406: Numerical Analysis – II **(L, T, P) = 4 (4+0+0)**

Unit	Contents of Course	Hrs.
I	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.	11
II	Numerical solution of Ordinary differential equations – Taylor series Method, Picard method, Runge-Kutta methods upto fourth order, Multistep method (Predictor-corrector strategies).	12
III	Stability analysis – Single and Multistep methods. BVP's of ordinary differential equations – Boundary value problems (BVP's), Shooting methods.	10
IV	Finite difference methods. Difference schemes for linear boundary value problems of the type $y'=f(x, y)$, $y''=f(x, y, y')$ and $y^{iv}=f(x, y)$.	11
	Total	44

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,
8. Introduction to Numerical Analysis, (Second Edition), Addition Wesley, 1979.